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PROJECT MEMO

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SUBJECT: Efficient Irrigation and Landscape Design Standards Literature Review

The purpose of this literature review is to explore approaches to regulating water efficient irrigation and landscaping across the United States, with a specific emphasis on methods that may more appropriately apply to the Spokane Valley Rathdrum Prairie Aquifer and the Spokane River region. The *Model Efficient Irrigation and Landscape Design Standards*, once developed, will aid municipalities and water purveyors to promote efficient water use and irrigation practices.

The first portion of this literature review will summarize the literature reviewed, and the major findings and conclusions. The second portion of this literature review will then answer several research questions, as developed by the Idaho Washington Aquifer Collaborative (IWAC).

For municipal clients throughout Washington and California, AHBL's planning and landscape architecture staff has considerable experience with the preparation of landscape codes, the design of landscape plans, and the review of landscape plans prepared by others. The following document is a literature review only. We will be providing our recommendations based on our experience as practitioners with our submittal of the first draft of the landscape code.

Review of Literature

In order to perform this literature review, sources were reviewed including guidance documents on water efficient landscapes, model water efficient landscaping ordinances, and ordinances adopted by several municipalities. The sources reviewed include the following:

- EPA Water Sense, Water –Smart Landscapes, 2013.
- DRAFT Model Landscape Irrigation Efficiency Ordinance, Proposed Design Guidelines, Arizona Department of Water Resources Tucson Active Management Area, Adapted from the California State Model Water Efficient Landscape Ordinance to meet the needs of the Tucson Metropolitan Area, 2002.
- West Valley City, Utah Municipal Code, Chapter 7-16, WATER EFFICIENT LANDSCAPE.
- Water-Efficient Landscape Design, A model landscape ordinance for Colorado's communities utilizing a water conservation-oriented planning approach, Colorado Department of Local Affairs, Office of Smart Growth, 2004.
- Guidelines for Model Ordinance Language for Protection of Water Quality and Quantity using Florida Friendly Lawns and Landscapes, 2003.
- Water Efficient Landscape Ordinance, City of Hayward, California.
- Landscape and Irrigation Design Standards, City of Lancaster, California, 2016
- City of San Bruno Water Efficient Landscape and Irrigation Guidelines, City of San Bruno, California

- St Johns River Water Management District, Landscape Water Conservation Ordinance Guidelines
- DRAFT Model Water Efficient Irrigation and Landscape Ordinance, Tampa Bay Water Member Governments, 2001
- DRAFT Irrigation Standards Ordinance and Procedures for the Tucson Metropolitan Area, Executive Summary, 2003
- DRAFT Utah Water Efficient Landscape Ordinance for Commercial Business, 2001
- REVISED FINAL DRAFT Standards for Landscape Irrigation in Florida, 2006
- Model Water Efficient Landscape Ordinance, California Department of Water Resources, 2010
- Water Efficient Landscaping Standards, City of Aspen, Colorado, n.d.

Background

The average American uses 100 gallons of water per day, the average family uses 320 gallons of water per day. The amount of water used outdoor, especially in the summer can exceed the amount used for all other purposes in the entire year. This is especially true in hot, dry climates.[1]

According to the Environmental Protection Agency (EPA) "of the estimated 29 billion gallons of water used daily by households in the United States, more than 8.5 billion, or 30 percent, is devoted to outdoor water use. In dry climates, a household's outdoor water use can be as high as 60 percent. The majority of this is used for landscaping. In fact, it is estimated that the average American home consumes 58,000 gallons of water outdoors each year, mostly for irrigation."

Some of the key ways to reduce outdoor water consumption include:

- Planting native plants. Native and low-water plants require little to no irrigation beyond normal rainfall.
- Group plants according to their water needs. Grouping plants into "hydrozones" allows you to water based on each zones specific needs.
- Maintain healthy soils. Healthy soils effectively cycle nutrients, minimize runoff and retain water.
- Reduce turf areas. Turf requires the highest amount of irrigation in traditional landscaping.
- Water wisely. Watering in the morning or evening can avoid the evaporation and wind that occur during the heat of the day.
- Incorporate mulch around shrubs and plants. Mulch aids in a greater retention of water by inhibiting weed growth, regulating soil temperature, and preventing erosion.
- Maintain mulch and remove weeds.

The type of irrigation system also plays a big role in water use. Manual watering with a handheld hose is the most efficient method. In-ground sprinkler systems and drop systems use up to 47 percent more water. In-ground sprinkler systems and drip irrigation systems must be operated property to be water efficient. Rain sensors and soil moisture sensors also help prevent waste by ensuring the sprinkler does not turn on during and immediately after rainfall or when soil moisture levels are above preprogrammed levels.

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[1] EPA Water Sense, Water –Smart Landscapes, 2013.

Research Questions

IWAC staff identified several research questions in their preparation of a draft Model Efficient Irrigation and Landscape Design Standards that our literature review sought to answer. These questions will help guide the development of a model ordinance and standards that can be applied within the Spokane Valley Rathdrum Prairie Aquifer and the Spokane River region.

1. **What are some other goals of the Model Efficient Irrigation and Landscape Design Standards?**

   The Water-Smart Landscapes publication by the Environmental Protection Agency may be a good source of inspiration for purpose statements for the model ordinance:

   - Reducing outdoor irrigation which can account for up to 60 percent of a household's water use.
   - Replacing eye-catching landscapes, which require extensive watering, fertilization, and pesticide application, with drought-tolerant and water-smart landscaping. These landscapes can be designed to be aesthetically pleasing, save water, and protect the environment.

   The California MWELO provides several goal statements that may be of use:

   - Creating the conditions to support life in the soil by reducing compaction, incorporating organic matter that increases water retention, and promoting productive plant growth that leads to more carbon storage, oxygen production, shade, habitat, and esthetic benefits.
   - Minimizing energy use by reducing irrigation water requirements, reducing reliance on petroleum based fertilizers and pesticides, and planting climate appropriate shade trees in urban areas.
   - Conserving water by capturing and reusing rainwater and graywater wherever possible and selecting climate appropriate plants that need minimal supplemental water after establishment.
   - Protecting air and water quality by reducing power equipment use and landfill disposal trips, selecting recycled and locally sourced materials, and using compost, mulch and efficient irrigation equipment to prevent erosion.
   - Protecting existing habitat and creating new habitat by choosing local native plants, climate adapted non-natives and avoiding invasive plants. Utilizing integrated pest management with least toxic methods as the first course of action.

   The City of Hayward, CA, has similar goal statements to the California MWELO:

   - Encouraging the use of a watershed approach and reducing compaction, incorporating organic matter that increases water retention, and promoting productive plant growth that leads to more carbon storage, oxygen production, shade, habitat and esthetic benefits.
   - Establishing provisions for water management practices and water waste prevention for existing landscapes.
   - Setting a Maximum Applied Water Allowance as an upper limit for water use and reducing water use to the lowest practical amount.

2. **Incorporate the use of reclaimed water into the design standards?**

   Most of the model and adopted ordinances do not require or discuss the use of reclaimed water or rainwater harvesting. The California Model Water Efficient Landscape Ordinance (MWELO), which many communities in California have adopted, provides provisions for encouraging the use of graywater systems for on-site landscape irrigation. In addition, provisions within the WELO provide exemptions for landscape areas with less than 2,500 square feet that meet their Estimated Total Water Use entirely through the use of graywater.

3. **Where should the ordinance apply and are there any exemptions that the model ordinance should include? Consider single-family, commercial, industrial and publicly owned facilities, common areas in multifamily developments, master planned communities, parks, schools, cemeteries, athletic fields and private sports facilities.**

   The California MWELO applies to all new landscapes 500sf or larger requiring a building or landscape permit, plan check, or design review, as well as rehabilitated landscape projects 2,500sf or larger requiring a permit or review. The Colorado model ordinance does not specify a threshold but simply states that it will apply to all new or renovated landscapes that require development review permits. This provides some flexibility for municipalities to adopt their own threshold, within the framework of their existing development review process.

   The California MWELO exempts existing landscapes, and cemeteries. However, agreements may also be entered into with other agencies such as water purveyors, to implement portions of the ordinance for existing landscapes, such as irrigation water use analyses, irrigation surveys, and irrigation audits to evaluate water use and provide recommendations to prevent water waste. West Valley City, Utah's Water Efficient Landscape chapter applies the ordinance only to single-family residential projects that require a separate review process.

4. **Should there be a threshold for a minimum size of a landscape area that the ordinance applies to?**

   Several of the ordinances specify a minimum size of the landscape area for when the ordinance applies. As a practical matter, this size threshold would only apply generally when development permits or review is required. This means that activities that would not require a development permit are not reviewed under the landscape provisions in many instances. The Utah model ordinance exempts any landscape area less than 2,500sf. In Arizona, landscapes under one-half acre are exempted.

5. **Should the ordinance apply to all new development and expansions only? Or include major renovations?**

   The City of Tucson has a provision for when the ordinance applies to expansions and whether the renovations require the entire site to conform to the landscape and water use standards. If the expansion is less than 25% of the floor area, lot coverage or vehicular use area for buildings greater than 10,000sf and 50% for buildings less than 10,000sf, the existing development of the site is subject to the zoning standards in effect at the time they were developed. If the expansion is greater than 25% for buildings greater than 10,000sf or 50% for buildings less than 10,000sf, then the new standards apply to the entire site.

   The California MWELO and California city adopted ordinances, Colorado model ordinance, and Utah model ordinance apply to just new or rehabilitated landscapes.

6. **Who is qualified to perform an irrigation audit post installation?**

   Most of the ordinances (including the California MWELO and the Colorado Water-Efficient Landscape Design model ordinance) specify that a person who is qualified to perform an irrigation audit must be certified by an accredited academic institution, professional trade organization, or other program such as the EPA WaterSense Irrigation Auditor certification program and the Irrigation Association's Certified Landscape Irrigation Auditor program.

7. **Should City staff conduct the final inspection and provide the certificate of substantial completion or should the applicant be required to contract a third party inspector?**

   The California MWELO and the Colorado Water-Efficient Landscape Design model ordinance specify that the inspection may be conducted by a local City/County inspector, or third party certified inspector. However, many of the locally adopted versions of these ordinances specify that the applicant is required to contract a third party inspector.

8. Should there be requirements for plants within street medians or public rights-of-ways to be drought tolerant/low-water use?

The California MWELO outright prohibits high-water use plants and irrigation within the median. Colorado's model ordinance allows plants of any water need, provided that the annual water use does not exceed the water allowance. Strips that are less than 8' in width, must be landscaped with low or very low water plants, though public street right-of-way plantings are exempt. West Valley City, Utah requires parking strips or landscape areas less than 8' in width to be landscaped with drought tolerant plants. Drip emitters or a bubbler are required to be provided for each tree. The City of Hayward, California, prohibits high water use plants as characterized by a plant factor of 0.7 to 1.0.

9. What is the minimum amount of mulch that is required to be applied?

The typical mulch requirement ranges from 3 to 4 inches. The City of Lancaster, California, requires only 2 inches of mulch for all landscaping outside of landscape maintenance districts and public rights-of-way, which require organic mulch at a three inch minimum depth.

10. Who is qualified to prepare a landscape plan?

Every model or adopted ordinance requires that a landscape plan be prepared by a registered landscape architect who holds a license in the state of which they are practicing.

11. Who is qualified to design the irrigation system?

Most of the ordinances require that the irrigation designer be a person certified to design irrigation systems by an accredited academic institution, professional trade organization (such as the EPA's WaterSense irrigation designer certification program or the Irrigation Association's Certified Landscape Irrigation Designer program), or another educational organization. The Utah Model Water-Efficient Landscape Ordinance for Commercial Businesses defines an irrigation designer as being a person certified by the Irrigation Association and/or a landscape architect.

12. How are sight distance triangles defined, if they are defined?

The Colorado Water-Efficient Landscape Design model ordinance defines a sight triangle as:

"the area on each side of a street or driveway intersection, measured from the intersecting point of the extended flow lines of the streets or street and driveway, to the points 50 feet back from that intersecting point, that is intended to remain free of obstructions that may impair a drivers safe sight distance to oncoming traffic."

Landscaping shall be no more than 30 inches high when located within the sight distance of street intersections. Tucson's Landscape and Screening code also requires vegetation to be less than 30 inches in height within the sight distance triangle.

None of the California ordinances define a sight-distance triangle. These standards do not define the plantings that can be placed within sight distance areas. Sight distance restrictions are established in local public works design standards.

13. Are fixed spray styles of in-ground sprinkler systems permitted? Is there a landscape area where spray irrigation is not permitted?

Fixed spray styles are commonly permitted but their locations are restricted (such as not being permitted within 24" of non-permeable surfaces). Fixed spray heads are also permitted around the perimeter of the turf areas directing spray into the turf area (in the City of Lancaster, CA), but must be installed at least 2 inches from hard surface edges and lawn edges.

Tucson, Arizona, however does limit the use of spray styles of sprinklers to only the "oasis area" of the landscape for turf.

14. Is sprinkler spacing specified? Or is spacing per manufacturer specification?

The adopted and model ordinances typically specify sprinkler spacing based on the manufacturer's specification. The City of Hayward, California's adopted ordinance and the Colorado model ordinance recommend head to head coverage.

15. When is ETO measured?

ETO is typically measured as the average annual rainfall. The California and Colorado model ordinances use an adopted ET rate to calculate a water budget based on the region you are located in.

16. Are there provisions for slopes where irrigation may not be installed?

No, there are no provisions that prohibit the installation of irrigation on steep slopes, Typically, irrigation is permitted on slopes greater than 25%-33%, however, it is limited to an application rate of 0.75-0.85 inches per hour.

17. Is there a threshold for when rain sensors and soil moisture sensors are required/recommended?

Most of the ordinances specify that rain sensors and soil moisture sensors are recommended, but there is no threshold for when they are required. The Utah model ordinance, however, requires irrigation systems that include an electric automatic controller to be equipped with an automatic rain shut-off device.

18. Are materials for drip irrigation lines specified?

The City of Lancaster specifies design standards for drip irrigation lateral lines to be PVC schedule 40 or class 200 pipe. The majority of the other design standards reviewed are silent as to the material of drip irrigation lines and whether they may be constructed of polytube.

19. Is an irrigation plan required before certificate of occupancy can be issued?

Yes, nearly all of the model ordinances and adopted ordinances specify that an irrigation plan is required to be submitted as part of the building permit process. The irrigation plan is typically included as part of the required landscape documentation package, which must be approved prior to the issuance of a certificate of occupancy.

20. Are there restrictions for irrigation based on the time of day? What are these restrictions? Are there provisions for the municipality to restrict watering to every other day when there is a declared drought?

Most of the ordinances do include restrictions for irrigation based on the time of the day. The California MWELO, West Valley City ordinance, Lancaster, CA ordinance, and Utah model ordinance all restrict this for overhead spray types only. The Colorado model ordinance and the Tucson ordinance do not specify whether the restriction only applies to overhead spray irrigation. The City of Tucson has an ordinance that allows the municipality to institute restrictions on outdoor irrigation during a water emergency, which may include a schedule designating certain outdoor watering days.

21. What is the typical plant establishment period?

The model ordinances and adopted ordinances range from 120 days to a year as the required plant establishment period. The City of Hayward, CA, requires the plant establishment period to be two years if irrigation will be terminated after establishment. The City of Lancaster, CA, specifies that the establishment period may be three to five years for native habitat management areas and trees.

22. What types of maintenance assurances are required for subdivisions/plats?

The Colorado model ordinance requires that all landscape improvements are installed prior to issuance of Certificate of Occupancy. If weather conditions prevent installation, a financial guarantee will be required and released once the landscaping is installed, however, assurances for ongoing maintenance are not discussed. The California MWELO and the City of Hayward, CA require that landscapes are maintained, and that a maintenance schedule be submitted with the Certificate of Completion.

23. Is a soil analysis required? What is the threshold for when this is required?

The City of West Valley, CA, requires a soils report where a site's irrigated landscape areas exceed 2,500sf. The Utah model ordinance has the same threshold The City of Hayward, CA, requires a soils analysis for all projects; however, it is due at different times depending on whether mass grading is proposed. If mass grading is proposed, the soil analysis report submittal can be delayed until the Certificate of Completion.

Landscape Irrigation Best Management Practices

May 2014

Prepared by the Irrigation Association and American Society of Irrigation Consultants

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The Irrigation Association and the American Society of Irrigation Consultants have developed the *Landscape Irrigation Best Management Practices* for landscape and irrigation professionals and policy makers who must preserve and extend the water supply while protecting water quality. The BMPs will aid key stakeholders (policy makers, water purveyors, designers, installation and maintenance contractors, and consumers) to develop and implement appropriate codes and standards for effective water stewardship in the landscape.

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Table of Contents

Foreword

The Irrigation Association [IA] and American Society of Irrigation Consultants [ASIC] have developed these landscape irrigation best management practices [BMPs] to promote efficient use of water in the managed landscape. There are a number of stakeholders including: water purveyors, system owners, irrigation consultants/designers, contractors, irrigation managers and landscape professionals as well as state, federal and public agencies, code developers, and building officials.

Managed landscapes, while highly visible users of water, provide ecological, economical and recreational benefits. It is the stakeholders' responsibility to advocate for efficient irrigation and to incorporate and promote all reasonable practices that minimize water consumption and waste. The broad and comprehensive nature of the best management practices and related practice guidelines define the elements of an efficient irrigation system and responsible water management. Specific benefits include:

- Enjoining the water purveyor and the landscape and irrigation industries in water planning and development of local strategies to manage irrigation water use.
- Improving irrigation efficiency to optimize water use in both existing and new landscapes.
- Reducing energy costs of treating and pumping water.
- Providing criteria to achieve the desired results of water use efficiency that fit the purpose and function of the managed landscape.

Landscape Irrigation Best Management Practices includes:

- Three BMPs that address the design, installation and management of irrigation systems.
- Practice guidelines that address ways to effectively implement the respective BMPs and can be adapted locally.
- Appendices that provide related information for the implementation or understanding of the BMPs.

The BMPs and related practice guidelines provide the basis for sensible, informed decision making regarding regional water use and potential response to drought.

As professionals engaged in making decisions about how water is used, it is important to consciously seek to evolve fundamental attitudes and values to better serve the community.

John W. Ossa, CID, CLIA
Chairman, Landscape Irrigation BMP Task Group

Section 1: Introduction

1.1 Purpose

The primary purpose of a landscape irrigation system is to deliver supplemental water when rainfall is not sufficient to maintain the turfgrass and plant materials to meet their intended purpose. A quality irrigation system and its proper management are required to efficiently distribute water in a way that adequately maintains plant health while conserving and protecting water resources and the environment. Assuring the overall quality of the system requires attention to system design, installation, and management. In particular, this includes the following:

- The irrigation system shall be designed to efficiently deliver water to the landscape.
- The irrigation system shall be installed according to the irrigation design specifications.
- The irrigation system shall be managed to maintain a healthy and functional landscape while conserving and protecting water resources.

1.2 Definitions

1.2.1 Landscape Irrigation Best Management Practice

Landscape irrigation BMPs improve water use efficiency, protect water quality and are sensitive to the watershed and environment. Landscape irrigation BMPs are economical, practical and sustainable, and they will maintain a healthy, functional landscape without exceeding the minimum water requirements of the plants or the maximum water allowance where applicable.

1.2.2 Practice Guidelines

Practice guidelines are recommended practices or principles that aid in successfully accomplishing the related BMP. The practice guidelines are meant to be a guide to develop criteria that address site-specific landscape irrigation needs. It is the responsibility of the framers of such specifications to adapt the guidelines to meet their local needs.

1.3 Qualified Irrigation Professionals

The implementation of these irrigation BMPs and practice guidelines requires a commitment from qualified irrigation professionals. "Qualified" includes being formally trained, certified, licensed where required, having successful experience completing projects of similar scope, or other similar qualifications that meet state and local requirements.

IA certifies individuals in design, contracting, and management of irrigation systems. The ASIC recognizes professional irrigation consultants [PIC] as irrigation professionals who have been peer reviewed and board approved for the design and management of irrigation systems. The best results come when there is collaboration between landscape and irrigation disciplines.

A listing of certified individuals can be found on IA's website at *http://www.irrigation.org*.

A listing of professional irrigation consultants can be found on the ASIC website at *http://www.asic.org*.

There may also be regionally appropriate certifications.

The BMPs as described in this document recognize there are other licensing and certifying organizations in the irrigation industry but these programs stand on their own merit and were not evaluated for this document.

Section 2: Landscape Irrigation Best Management Practices

To assure the overall quality of the irrigation system and to promote irrigation efficiency; the following best management practices need to be implemented.

BMP 1: Design the Irrigation System for Water Use Efficiency

The irrigation system shall be designed to deliver water precisely and efficiently to maintain the function and purpose of the managed landscape while complying with any local limitations and requirements.

Each BMP and the practice guidelines that support them were developed to meet the criteria of the following tenets of best management practices. To be effective, a BMP must

1. *Be applicable to any location, while allowing for site-specific conditions.*
2. *Protect the watershed and water quality and conserve water resources.*
3. *Be sustainable by allowing for improvement through adoption of new technology, knowledge, and innovative solutions.*

BMP 2: Install the Irrigation System to Meet the Design Criteria

The irrigation system shall be assembled and installed according to the irrigation design specifications, locally applied codes and standards, and manufacturers' product requirements. The qualified irrigation contractor or installer shall execute the installation per the plans and specifications and be capable of quality workmanship and the safe use of proper equipment.

BMP 3: Manage Landscape Water Resources

To conserve and protect available water resources, the management of the irrigation system will optimize the efficient use of water to maintain a healthy and functional landscape with optimal irrigation system performance. This entails careful and active management of the system and adherence to all applicable watering limitations within the jurisdictional area. Management includes active irrigation system maintenance, scheduling, monitoring, and evaluation of water use, landscape health, and appearance.

> "A thing is right when it tends to preserve the integrity, stability and beauty of the biotic community. It is wrong when it tends otherwise."
>
> Aldo Leopold
> *A Sand County Almanac*, 1949

Section 3: Practice Guidelines

All water resources are important and these practice guidelines will hold true for projects that use water supplied by a purveyor as well as on-site developed water resources. Vital to water efficient design and management is a plant palette that is appropriate to the region and soils that have been properly prepared. Knowledgeable landscape water management must focus on how the soil and irrigation work together creating the foundation for a healthy landscape. Not all of the listed guidelines will be implemented on each site, but the landscape water manager needs to be aware of the ones that have specific application.

PG 1: Practice Guidelines for Designing an Irrigation System

Practice guidelines can be used to develop site-specific irrigation plans, details and specifications while optimizing system efficiency. Implementation of these guidelines is best done as a collaborative effort between landscape and irrigation practitioners and the authority holding jurisdiction. The practice guidelines shall be compatible with state and local laws, rules, regulations, codes, or ordinances.

The irrigation designer shall perform a project analysis and a comprehensive site inventory as part of the design process to ensure that the irrigation system is designed to efficiently apply water, which enables the effective management and protection of water resources.

The landscape irrigation BMPs are principles that work interdependently with each other to efficiently use water. The Practice Guidelines may be adapted in principle to suit the constraints and opportunities inherent in water issues that are best solved on a local basis.

The landscape irrigation best management practices and practice guidelines should work in harmony with local or state initiatives such as California's Model Water Efficient Landscape Ordinance or state licensing

1. Irrigation Design Package

1.1 Project Analysis and Basis of Design

a. Include statement or narrative that identifies the assumptions used for design purposes such as: water sources to be used, need for a temporary system, total landscape water demand based on area, effective rainfall, water window, assumed irrigation efficiency and energy constraints for system operation.
b. Confirm the irrigation design plan accounts for local water laws or regulations, permitting requirements and applicable codes.
c. Convey how the system should be operated to use water resources efficiently to achieve the desired function of the landscape.
d. Select product preferences.
e. Identify a project budget and phasing.

1.2 Plan Submittal

a. When required, a complete plan package including the design, details and specifications shall be submitted to the appropriate governing agency for approval prior to installation of the system.
b. Typically, the irrigation designer submits plans to the client for package submittal with a landscape design.

1.3 Other

a. Consider future needs such as expansion of the system to accommodate further development.
b. The irrigation designer shall verify that a detailed controller map showing the location of sprinklers, valves and valve zones, etc., for the irrigation system is provided to facilitate water management and maintenance.
c. When the irrigation system needs to be inspected after installation or commissioned to verify proper performance, the irrigation designer should be involved in that process. See appendix A for additional information.

Minimum Plan Requirements

- The graphic presentation of the diagrammatic design shall include clear and concise reproducible drawings with all components sized, symbolized and keyed in a distinctive manner.
- Drawings are to be at a suitable scale to be clearly legible and have a north arrow.
- Sheet sizes are to match whole package documentation.
- Complete installation details shall accompany the drawings. Details to be project specific.
- Written specifications unique to the project shall supplement the drawings detailing materials and workmanship to be used in the installation.

2. Site Inventory

2.1 Identification

a. Weather considerations
   1) Historical temperature and rainfall data
   2) Prevailing wind direction and speed
b. Physical features
   1) Base area measurements (square footage)
   2) Site grading and drainage plans
   3) On-site water bodies/water features
   4) Conservation, utility or right-of-way easements, etc.
   5) Buildings, decks, parking lots, roadways and other structures
   6) Roof-top gardens, living walls, etc.
   7) Walkways, patios and other secondary hardscape features
   8) Exterior lighting plan when available
   9) Location of site utilities when available
c. Hydrozone areas
   1) Soil type (e.g., clay, loam, sand, etc.) and soil profile if applicable
   2) Exposure: sun/part shade/full shade — consider seasonal variation
   3) Reflected light and/or heat from adjacent building or hardscape
   4) Plant materials
      - Type of turfgrass
      - Annual color/bedding plants
      - Herbaceous perennials
      - Ground cover
      - Trees, shrubs/woody plants
      - Desert or drought tolerant plants
   5) Sloped areas/topography
   6) Special situations, such as building overhangs, on-structure planting such as green roofs or living walls, container planters, shallow planting areas, etc.

2.2 Calculations

a. Estimate water requirement.
   1) Identify the peak water demand month during the growing season (greatest reference ET and least rainfall).
   2) Estimate plant-water requirement for each hydrozone and/or irrigation zone by modifying the reference ET with appropriate plant factors that consider the functional purpose and aesthetic quality intended. Sum the total water need for each hydrozone and/or irrigation zone to calculate the landscape water requirement.
   3) Where water budgets are used to influence the landscape design, verify that the landscape water requirement is less than the landscape water allowance or allotment including expected irrigation efficiency. See appendix B for more information.

There are regional variations in key terminology and methodology; for example:

California's Model Water Efficient Landscape Ordinance uses "maximum applied water allowance," or MAWA.

Sustainable Sites Initiative uses "baseline water requirement," or BLWR.

4) If the water requirement is greater than the allowance, consult with the landscape architect or designer to make landscape modifications or adjust plant performance expectations within specific hydrozones.
5) Estimate any leaching fraction needed when a lower quality water source is used.

b. Establish water window and frequency.
1) Reasonable water windows should be less than 10 hours during normal conditions.
2) Irrigation frequency should be appropriate for the climate, soil type and plants used in the landscape including the establishment period.
3) Comply with local watering restrictions.
4) Water source, size and pressure and/or pump sizing must be considered.
   - If the water source and point of connection [POC] already exist, determine the water window that will be needed to meet peak demand.
   - For new water connections, the water window is used to determine the required capacity of the water tap or POC.

c. Calculate base irrigation schedule.
1) Determine minutes of run time for each irrigation zone to meet peak demand.
2) Compare total minutes of run time to water window.

2.3 Minimum Design Requirements

a. Provide separate irrigation zones to meet unique water requirements for each identified hydrozone.
b. Follow manufacturers recommendations for equipment performance.

2.4 Additional Considerations

a. Note if special trenching or installation techniques are required.
b. Identify existing specimen or heritage trees or other special features.
c. Consult with landscape designer to identify additional efficient water-use strategies in the landscape.

Intent: *The irrigation system shall be designed to facilitate installation and the long-term maintenance of the system as the landscape matures. Where systems are to provide a temporary plant establishment service or are for a specific function such as leaching, hardware appropriate to that function and longevity requirement shall be selected.*

3. Select Water Sources for the Irrigation System

3.1 Identification

a. Consider all sources of legally available water on-site that can be used for irrigation and will help minimize the amount of potable water to be used for irrigation.
1) On-site developed water
   - Rainwater harvesting
   - Storm water capture
   - Graywater
   - Process water
   - Foundation water
   - Air-conditioning condensate

2) Municipally reclaimed water (abide by local codes and constraints)
3) Groundwater
4) Surface water such as lakes, streams, rivers or canals
5) Potable water supply
6) Identify class of contaminant in water supply (e.g., particulate, biological, chemical)
7) Other

b. Show source of water and POC for irrigation system.
1) Exact location/address of each POC specifying water source/type
2) Type, size and length of meter service piping
3) Meter type and size
4) Static pressure and available flow
5) Pump station or booster pump location and performance requirements (flow and pressure) when required
6) In freezing climates, provide a method to winterize the system.

c. Dedicated irrigation-only meters and flow sensors (sizes and locations).

d. Backflow prevention assemblies (type, size, and location).
1) Locate downstream of POC on potable water service.
2) Place in non turfgrass areas where possible and accessible for servicing.
3) Protect the backflow assembly from vandalism or theft.
4) Protect the backflow assembly from freezing where necessary.

3.2 Calculations

a. For municipal water supplies, calculate maximum safe flow rate.
1) The maximum allowable pressure loss through the meter should be less than 10 percent of the static pressure at the meter.
2) The maximum flow rate through the meter should not exceed 75 percent of the maximum safe flow through the meter (refer to charts for the specific type of meter).
3) The velocity of the water through the service line supplying the meter should not exceed 7.0 feet per second.

b. For on-site developed water sources.
1) Calculate reliable yield for all available water sources.
2) Determine practical storage capacity for the water sources to match climatic conditions.
3) Match available water and storage with water requirements.

Local plumbing codes and water purveyor service rules shall determine appropriate backflow type. Designer shall specify enclosure if required.

3.3 Additional Considerations

a. Comply with all state and local laws regarding alternate water sources.

b. Comply with all state and local laws regarding storage tanks and/or reservoirs.

c. Use lowest acceptable quality of water and supplement with higher quality of water when necessary.

d. Assure water quality will not harm plant growth and development.

e. Provide cost-benefit analysis for using alternate water sources and help the owner make an informed decision.

4. Irrigation Components

4.1 Identification

a. Appropriate emission device for each zone
   1) Sprinkler zones
   2) Drip/microirrigation zones
b. Valves sizes and locations
   1) Remote control zone valves
   2) Manual and specialty valves
c. Pipe layout including sizes, main line and lateral lines
d. Controller(s) and location(s)
e. Sensor types and their locations
   1) Weather sensors such as solar radiation, temperature, rain, and/or freeze sensors
   2) Soil moisture sensors
   3) Flow sensors
f. Drip/microirrigation devices
   1) Drip valve, pressure regulator, filter assembly
   2) Supply/exhaust manifold location
   3) Flush plugs and/or air/vacuum relief valves
   4) Emitter flow rate and spacing if using inline drip tubing
   5) Tubing depth
   6) Lateral row spacing

4.2 Design Requirements

a. Use symbols indicating the location of the various irrigation components.
b. Specify manufacturer, model, type and size of all components.
c. Develop a key of the symbols to facilitate plan reading.
d. Provide specific installation details for all components.
e. Provide written site-specifications for the project including general conditions.

5. Sprinkler Selection and Spacing

5.1 Identification

a. Select specific sprinkler heads and nozzles to apply water uniformly to the target area.
b. Select products suitable to the landscape requirements.
c. Select products to facilitate long-term reliability and serviceability.
d. Select products that are compatible with the quality of the proposed water source.

5.2 Calculations

a. Calculate the precipitation/application rate of the sprinklers for each zone.
b. For turfgrass areas, specify a minimum low quarter distribution uniformity [DU_{lq}] based upon size and geometry of the area.

5.3 Minimum Design Requirements

a. Do not exceed manufacturer's sprinkler spacing recommendations.
b. Design system so sprinklers operate within manufacturer-recommended operating pressure.
c. Use matched precipitation rate sprinklers (+/– 5 percent) within a zone.
d. Design system to target each planting area with no overspray of impervious surfaces or adjacent planting areas. Prevent runoff of water from the site.

e. Space sprinklers a minimum of 2 inches from hard surface edges but farther than 2 inches where possible to minimize overspray, back-splash or wind drift.
f. Specify a pop-up height of the sprinkler to clear interference from vegetation.
g. Include protective covers/lids specifically designed for use on athletic fields for sprinklers in “play” areas such as athletic fields.
h. Include purple markings on sprinklers and valves when using municipally reclaimed water sources.
i. Design the system to avoid or eliminate low-head drainage.
j. Avoid above ground fixed risers near pedestrian walkways, bicycle paths, etc.

5.4 Additional Considerations

a. If pressure exceeds equipment recommended operating range, use pressure regulating equipment to optimize performance.
b. Use lower precipitation rate sprinklers on slopes or heavy soils to reduce runoff potential.
c. Use check valves to control low-head drainage.
d. In areas of high vandalism use vandal-resistant products and parts to minimize potential damage or theft of the sprinklers.
e. Use drip irrigation instead of spray sprinklers in narrow or complex shaped areas.

6. <u>Valves and Valve Boxes</u>

6.1 Identification

a. Remote control zone/station valves
b. Manual isolation valves
c. Pressure-regulating valves appropriate for the water source
d. Specialty valves
   1) Pressure relief valves
   2) Air release valves
   3) Quick coupling valves
   4) Drain/flush valves
   5) Strainers and filters

6.2 Calculations

a. Designate an acceptable operating pressure range (minimum to maximum).
b. Calculate the flow rate for each zone control valve.

6.3 Minimum Design Requirements

a. Install valves to accommodate identified hydrozones.
b. Size the zone control valve so that flow through the valve is within the manufacturer’s stated flow range and so that pressure loss does not exceed 10 percent of static pressure.
c. Install valves either above grade or below grade in a valve box large enough to service or access.
d. Valve box location should consider safety and aesthetics of the site, along with long-term durability of the valve box.
   1) Keep valve boxes out of athletic fields or recreation areas where they may interfere with use or aesthetics of the area.
   2) Keep valve boxes out of pedestrian or equipment pathways.
e. Use valve boxes colored purple when using municipally reclaimed water or as applicable by code.

f. Install the valve and valve box over a layer of coarse stone or gravel for stability and drainage. Maintain a physical separation (air space) between the layer of stone/gravel and the valve.
g. Valves installed at or below grade shall be enclosed in a valve box with sufficient strength to withstand the loads reasonable to expect in the installation location.

6.4 Additional Considerations

a. Install a master valve on larger systems.
b. When pressure is excessive (greater than 15 percent above recommended operating pressure), the following equipment could be used:
   1) Pressure-reducing valve(s) at point of connection
   2) Pressure-regulating device that can be added to the zone control valve
c. Specify zone control valves with flow control.
d. Specify fittings to allow for the easy removal of the remote control valve for servicing if necessary.
e. Use isolation valves on larger systems to facilitate servicing.
f. Install chemigation or fertigation equipment downstream of an approved backflow prevention assembly.
g. Consider locking lids on all valve boxes.

7. <u>Pipes and Fittings</u>

7.1 Identification

a. Type of pipe to be used for main lines and laterals lines:
   1) Polyvinyl chloride [PVC] polyethylene [PE], high-density polyethylene [HDPE] or other
   2) Pipe classification shall be indicated on plan key and specifications.
   3) The pipe shall be clearly marked with the manufacturer, size, schedule and/or pressure rating.
b. Colored pipe shall be used when required by code:
   1) Purple pipe for reclaimed or alternate water sources
   2) Brown or UV resistant pipe for aboveground installation (usually on steep slopes)
c. Minimum size for each pipe section
e. Type of fittings to be used for main lines and for laterals
f. Type of swing joint to be used with each type of sprinkler head

7.2 Calculations

a. Pressure loss for the “worst-case” zone. This may be the largest zone and/or the farthest zone from the POC and/or the zone with the greatest elevation change.
b. Flow in plastic pipe operating at full system capacity
   1) Velocity shall not exceed 5 feet per second for pipes 3-inch diameter or smaller. For pipes larger than 3-inch diameter the velocity should be lower.
   2) Pressure variation within a zone shall have less than 10 percent variation.
   3) Surge pressures in the main line shall be less than the safety factor of the piping.

7.3 Minimum Design Requirements

a. Piping
   1) The working pressure rating of the mainline pipe should be a minimum of 200 psi or at least twice the anticipated design pressure of the system, whichever is greater.
   2) Mainline piping should be sized to optimize pressure/flow conditions and should have the same pressure rating throughout.

3) Lateral pipes should have a pressure rating at least two times the operating pressure of the sprinklers.
4) Lateral piping should be sized to minimize pressure losses and optimize flow conditions.

b. Depth of pipe bury

1) The minimum depth of soil cover shall conform to local codes and/or as shown or listed in the drawings, details or specifications. When pipe bury is not listed on the plan, the generally accepted practice for pipe bury is the following.

Minimum cover measured from the top of pipe (or as specified)		
	Main line {in.}	Lateral lines {in.}
Residential	12	8
Commercial	18	12
Under vehicular paving	24	24

2) Backfill shall not have rocks or debris greater than ½-inch in size next to the pipe.

c. Fittings

1) Pipe fittings and connections shall be suitable for the type of pipe, exposure, operating pressure and flow applications.
2) Gasketed fittings on piping shall have restraints or thrust blocking.
3) HDPE fittings that are fusion or socket joined shall have the same dimension ratio [DR] as the pipe.
4) Fittings for PE pipe shall be insert-type or compression-type, suitable for the size and pressure rating of the system and using suitable clamps.
5) Threaded PVC pipe for nipples shall be Schedule 80 or better.

7.4 Additional Considerations

a. Sleeving and conduits

1) Under vehicular paving, pipe shall be installed in a sleeve made of a permanent rigid material (e.g., PVC at least Schedule 40 or Class 160, whichever is strongest).
2) Sleeving should be twice the size of the piping or wiring bundle that it will hold (2-inch pipe in a 4-inch sleeve and wires that fit in a 1-inch conduit shall have a 2-inch sleeve).
3) Pipe and wire shall be in separate sleeves.
4) Conduits for wiring should be laid parallel, not stacked, to facilitate future service with horizontal separation between the conduits.
5) Sleeving should extend a minimum of 2 feet beyond the edge of hard surfaces.
6) Subject to local authority holding jurisdiction.
7) Pipe sleeves should be marked for future location.

b. Fittings

1) Fittings for PVC
    - Fittings 4 inches and larger shall be gasketed fittings, preferably ductile iron.
    - Fittings 3 inches and smaller shall be gasketed, solvent welded or push-on style.
2) For PE pipe, worm gear clamps shall be used exclusively in sizes 1½-inch and larger.
3) Connection to sprinklers
    - For sprinklers with a ½-inch inlet, flexible swing pipe assembly or swing joints shall be used.

- For sprinklers with a ¾-inch inlet and larger, use swing joints that are made with rigid piping and multiple elbows to allow for multidirectional adjustment.

8. Drip/Microirrigation

The rate of soil drying and the elements that influence the drying of the landscape edge may be significantly different than the middle areas of an irrigation zone.

8.1 Identification

a. Statement of intent: Identify if system is intended as a permanent system for long-term maintenance or a temporary system for plant establishment, after which it is to be abandoned. State what period of time constitutes "plant establishment."
b. For design purposes, identify the soil type.
c. Identify emitter types for various hydrozones.
   1) Specify pressure-compensated emission devices to improve overall uniformity.
   2) Identify flow rate and operating pressures.
d. Water quality
   1) Identify the proper type of filtration.
   2) Identify the need for chemical additives.
   3) See table 1 for water quality recommendations.

8.2 Calculations

a. The water delivery rate should be proportional to the plant type and size.
   1) Application rate per zone
   2) Management allowed depletion factor
   3) Monthly zone run times based on local historical evapotranspiration [ET]
b. Create a separate schedule for plant establishment.

8.3 Minimum Design Requirements

a. Create separate drip irrigation zones for each hydrozone type where drip irrigation will be used. Don't mix subsurface drip with other drip areas.
b. Keep drip/microirrigation zones separate from other sprinkler zones.
c. Emitter placement
   1) For line-source drip irrigation, provide emitter and row spacing guidelines based on soil type and site conditions.
   2) For subsurface line-source drip irrigation, provide guidelines for location of subsurface drip irrigation laterals from hardscape edges and uncontained landscape areas.
   3) For point-source emitter systems, emission points to new plants should be located midway between the edge of the root ball and the crown of the plant.
   4) For permanent drip irrigation systems, provide sufficient emitters to wet at least 70 percent of the mature root zone.
   5) Provide isolation valves to separate drip lines used for establishment from those to be used for long-term maintenance.
   6) On slopes, locate the majority of emission points on the upslope side of the plant crown.

The emission product and system layout is based on plant density. A grid layout tends to be employed in high density plantings, while point source placement is used in lower density plantings.

7) Where soil texture, tilth, or slope are likely to induce runoff, provide for small basins to mitigate runoff.

d. Piping
   1) Systems shall be looped (where practical) to improve system hydraulics and mitigate possible contamination of tubing if system is damaged. Avoid any dead ends that cannot be flushed.
   2) On slopes, run the tubing on contour to the slope to keep each run of the tubing at approximately the same elevation.
   3) For line-source systems, expand row spacing over approximately the lower third of a slope. Conversely, compress row spacing at the top of the slope.
   4) Ensure main and lateral sizing will allow for proper flushing.
   5) Specify trench filling and compaction method for subsurface drip irrigation installation.

e. Pressure regulation
   1) Pressure shall be regulated to the manufacturer's recommended range for distribution hardware.
   2) Pressure regulation devices shall be sized for the design flow rate of the irrigated zone and should accommodate flow rates during system flush.

f. Filtration
   1) Identify class of system contaminant: particulate, organic or chemical.
   2) If filtration element is a screen filter, specify mesh size and equivalent micron rating.
   3) If filtration element is a disk filter, specify mesh size and equivalent micron rating.
   4) If filtration is by media filter, identify media sand sizes and their micron equivalent.
   5) Identify acceptable pressure loss through filter and threshold for maintenance event.

g. Flush valves
   1) Install flush valve in a valve box.
   2) Follow the manufacturer's recommendation for maximum system size per flush valve.
   3) Multiple flush points on a zone may be necessary for large or complex shape areas.
   4) Ensure adequate flow is available to remove contaminant during flush/back flush as appropriate.
      - Suggested flushing velocity for potable water is 1 foot per second.
      - Suggested flushing velocity for nonpotable water is 2 feet per second.

h. Air/vacuum relief and check valves line-source installations
   1) Use air/vacuum relief valves to minimize ingestion of contaminants into distribution piping.
      - All laterals within the elevated area shall be connected with an air relief valve except for emitters that incorporate a check valve and meet manufacturer requirements for proper operation.
   2) Follow manufacturer's recommendation for maximum system size per air relief valve.
   3) Determine air vent sizing by the operating flow rate for relatively flat sites.
   4) Determine air vent sizing in accordance to the maximum drainage flow rate for sites with slopes and varied topography.
   5) Install check valves in the headers and footers to mitigate lateral drainage to the low point if not included in the emitter device; accompany the check valve with an air relief valve at the highest location within the (sub) section of the zone.

8.4 Additional Considerations

a. Consider differing plant-water requirements, root zone-depths and slope. Use separate drip/microirrigation zones where practical.
b. Recommend the use of the same emitter type and output within a zone.
c. Recommend a fitting at the flush valve to accommodate a pressure gauge.
d. Utilize a visual pop-up indicator to verify the drip/microirrigation zone is pressurized and operating. Locate this system operation indicator within a foot of the flush valve.
e. For trees and shrubs it may be necessary to place tubing (permanently or temporarily) on top of rootballs during establishment to hydrate root ball.
f. Management strategies
    1) Recommend the installation of a water meter or flow sensor, where possible, to capture data for management purposes.
    2) Recommend a controller with capability of multiple start times or cycle/soak feature to deliver pulse irrigation for establishing and sustaining a wetted pattern as well as achieving optimum irrigation efficiency.
    3) Establish system maintenance protocols.
        - Based on water quality, consider installation of chemical-injection system to address tubing /emitter maintenance.
        - Identify vertebrate and insect control strategy.
        - Identify strategy to manage soil salinity, when necessary.
g. Special considerations for subsurface drip irrigation [SDI]
    1) When designing subsurface drip, the primary movement of water through the target root zone will be by capillarity rather than gravitational.
    2) Nutrient management must be considered based on climate conditions.
    3) For seeded areas, provide guidelines for the use of temporary overhead spray to augment seed germination.
    4) For sod, provide guidelines for ensuring adequate soil moisture in advance of sod installation.

Table 1.

Water Quality Assessment

Water Quality – Irrigation water should be assessed to determine its suitability for irrigation. This is done in order to recommend water treatment when required. The assessment should identify the chemical characteristics of the water and address possible problems with soil salinity and plant health caused by the use of the water. The following table includes water quality tests to be completed before designing or installing a system when non-potable water sources are considered for use.

			Level of concern	
	Units	**Low**	**Moderate**	**High**
pH		<7.0	7.0–8.0	>8.0
Electrical conductivity [EC]	dS/m	<0.75	0.75–3.0	>3.0
Total dissolved solids [TDS]	mg/L	< 500	500–2,000	>2,000
Suspended solids	mg/L	<50	50–100	>100
Nitrate nitrogen [NO_3]	mg/L	<5	5.0–30	>30
Iron [Fe]	mg/L	<0.2	0.2–1.5	>1.5
Hydrogen sulfide [H_2S]	mg/L	<0.2	0.2–2.0	>2.0
Manganese [M_n]	mg/L	<.01	0.1–1.5	>1.5
Boron	mg/L	<0.7	0.7–3.0	>3.0
Chloride	mg/L	<142	142–355	>355
Chloride	meq/L	<4.0	4.0–10.0	>10.0
Sodium	Adj SAR	<3.0	3.0–9.0	>9.0
Bacteria count	# / mL	<10,000	10,000–50,000	>50,000
Escherichia coli [E. coli]	CFU			<100 CFU /100 mL

Adapted from Hanson et al., 1994 and Hassan, 1998

9. Controllers and Wiring

9.1 Identification

a. Controllers shall list manufacturer, model number, and station count and how it will be installed in the field.
b. Wiring shall identify the gauge of wire and insulation rating for underground installation.
c. Coverage depth for wires
    1) Wires and cables carrying up to 30 volts shall be installed with a minimum of 12 inches of cover.

2) For irrigation controller output cables carrying more than 30 volts (such as decoder-to-solenoid) and where the controller is UL-listed as a "power limited power source" (Class 2 or Class 3), minimum depth of burial is 12 inches.
3) For wires and cables carrying more than 30 volts, follow local and national codes.

9.2 Minimum Design Requirements

a. Controllers
   1) Specify the location of the controller(s) on the plans.
   2) Specify any required sensors.
   3) Ensure the controller features include multiple programs, multiple start times, sensor inputs, lithium battery to retain programs during power outages, etc.
   4) Controller map to denote the boundaries of each irrigation zone (differentiated by using colors). The controller map should be developed by the designer and handed off to the installer.

> ***Sensors***
>
> *1) Rain, freeze, and/or wind sensors can suspend irrigation during weather conditions that are unfavorable for irrigation.*
>
> *2) Soil moisture sensors will monitor soil moisture and can suspend or initiate irrigation depending on the soil moisture conditions.*
>
> *A separate common wire from the controller to each hydrozone type will provide flexibility in the use of sensors to manage the irrigation system.*

b. Wiring
   1) All underground wires shall be insulated copper conductors and UL-listed for direct burial.
      - Low voltage wiring (less than 30 volt) to control valves shall be type PE or type UF.
      - Gauge of wire shall meet manufacturer's recommendations depending on length of run.
      - Wiring for two-wire systems shall be specifically manufactured for the control system being used.
      - Use of decoder-to-solenoid cable (paired multicolored wires in a single cable) may be appropriate on two-wire systems.
   2) Wires must be installed to allow for expansion and contraction, using
      - "Snaking" the wire on straight runs.
      - Wire loops at bends.
      - Expansion coils at connections or at the solenoid valve location.
   3) Electrical connections
      - All electrical connections shall incorporate a solid mechanical connection of the copper conductors using a UL-listed device and a waterproof kit for electrical insulation of the mechanical connection.
      - Connector assemblies shall be listed under UL 486D.
      - Grounding, when required, shall follow the detailed plan, manufacturer's recommendation, and local and national codes.

9.3 Additional Considerations

a. Controllers
   1) Use smart controllers that can incorporate ET information or sensor inputs to initiate or suspend irrigation and that can adjust irrigation schedules to meet plant water needs.
   2) Use controllers that can be monitored remotely or send alarms to notify the water manager of flow problems in the field.
   3) When selecting a controller that has two-way communication such as Internet access, consider units that track and report levels of water usage.

> ***Smart Controllers***
>
> *Smart Water Application Technologies [SWAT] is a collaborative initiative between water providers and the irrigation industry. SWAT identifies irrigation products that can improve irrigation efficiency and writes testing protocols to validate manufacturer claims for product performance.*
>
> *Reports are available for climate-based smart controllers, soil moisture sensors and rain sensors, and testing protocols have been written for irrigation sprinklers and nozzles.*
>
> *Performance reports and summaries are posted at www.irrigation.org/SWAT.*

b. Wiring
   1) Wire splices should be in valve boxes so they can be readily located.
   2) Wire shall be in electrical conduit meeting local codes using sweep ells when installed into the controller location.
   3) For two-wire systems, specify appropriate tools for wire stripping.
   4) If the controller location is at a low point, ensure adequate drainage of the conduit and pull boxes.
   5) Wireless sensors (rain, soil moisture, flow, etc.) shall follow manufacturer's recommendations for proper operation and installation.

10. <u>Controller Maps and Base Schedule</u>

10.1 Controller map

a. The controller map should be developed by the designer as part of the design package and handed off to the installer on new projects.
b. The controller map should be modified in the field after the project has been installed.
c. The controller map should denote the boundaries of each irrigation zone (differentiated by using colors.) See appendix D for an example.
d. The controller map should correlate with the stations on the controller showing
   1) Area of the irrigation zone
      - Station number
      - Square footage
      - Plant type or water use category
   2) Location of point of connection, meters, sensors, etc.
e. The controller map should be laminated and placed adjacent to or within the controller.

10.2 Base Schedule

a. Base schedule should be for a week of peak demand showing:
   1) Amount of water to be applied
   2) Precipitation rate of the zone
   3) Minutes of run time and number of cycle starts
   4) Seasonal adjust settings for other periods of the growing season
   5) Flow rate of the zone
b. Settings to be used if a smart controller is installed
   1) For weather-based controllers
      - Soil type and slope
      - Plant factors
      - Precipitation or application rates
   2) For soil moisture-based controllers
      - Settings for the soil moisture sensor to initiate or suspend irrigation
c. Base schedule information should be posted adjacent to or within the controller.

10.3 Record Keeping

a. Provide copies of the updated record drawings to owner, owner's representative, and landscape and irrigation managers.
b. Irrigation designer shall store electronic copies of the plans for a minimum of three years.

PG 2: Practice Guideline for Installing an Irrigation System

A qualified irrigation contractor shall be selected to install the irrigation system based on the requirements of PG 2. The irrigation contractor shall test the completed system to verify that the system operates according to the design criteria.

The following practice guideline helps meet the requirements of BMP 2. PG 2 intends to facilitate the development of minimum requirements and expectations for the proper installation of an efficient irrigation system. The successful implementation of these guidelines is best done as a collaborative effort between practitioners, property owners and governing agencies to meet local conditions and circumstances that will protect the watershed while maintaining a viable and functioning managed landscape. The means, methods, and outcomes derived from these guidelines should seek to be economical, practical, and sustainable.

The contractor shall adhere to the following:

1. <u>**Prior to Installation**</u>

1.1 Contact all appropriate utility companies prior to beginning installation to locate underground utilities including gas lines, electrical, telephone, cable TV, and so forth. Installation shall not start until all underground utilities are located and marked.

- a. The contractor/installer shall coordinate with the property owner to locate, identify and mark all privately owned underground utilities.
- b. The following free notification services are available: call 811 or www.call811.com.

1.2 Prior to beginning the installation, verify that the water sources, various points of connection (including pump stations), flow rate, and static and dynamic pressures meet design criteria. If there is a discrepancy, notify the irrigation designer to make irrigation design modifications.

1.3 Review irrigation plans and actual site conditions prior to installation. Provide submittals where required by plans and specifications. Substitution of materials must be pre-approved prior to installation. Inform the designer of conflicts and obstacles not shown on design (such as hardscape features, plantings, utility boxes, etc.) and review possible solutions.

1.4 Obtain any required permits prior to beginning the installation.

2. <u>**During Installation**</u>

2.1 Irrigation systems shall be installed in a manner conforming to the irrigation design plans and specifications, the design intent, applicable codes and standards, in conformance to the manufacturers' installation instructions.

2.2 Avoid disturbing and damaging existing trees, shrubs, and other plant material including root systems from construction and installation activities.

2.3 Inform the property owner or his/her representative and irrigation designer of unusual or abnormal soil conditions that may impact the design and management of the irrigation system.

2.4 Ensure sediment and erosion control measures are included in the scope of work and comply with local codes and regulations.

2.5 Ensure all sprinklers and valve boxes are set to proper grade and that valve boxes are properly supported.

2.6 Wire the valves in a logical sequence (for example, walking order clockwise from the controller) for ease of maintenance and management.

2.7 Make all necessary final sprinkler adjustments to avoid unwanted overspray and to ensure sprinklers are precisely set to water only the target areas.

3. Following Installation

3.1 Test the irrigation system to verify the operating pressure and ensure that there are no leaks and components are adjusted correctly to meet the design criteria.

3.2 Program the irrigation controller with the irrigation schedule that will meet the landscape water requirement for the current time of year. The schedule will take into account site conditions and will mitigate runoff. Produce a written copy and post the controller settings so they can be used for review and reference.

3.3 Explain to the end user (owner, owner representative, or landscape maintenance personnel) the location and operation of the controller, valves, sensors, pressure regulators, backflow device, sprinkler heads, and drip/microirrigation devices. Inform the owner of features and capabilities of the system and furnish product literature, warranties, or operating manuals.

3.4 Provide the end user (or owner) with recommendations and schedule for irrigation system maintenance.

a. Maintaining proper operation of system components
b. Winterization procedures (including spring start-up) where applicable
c. Testing of backflow prevention assembly per local code
d. Periodic visual inspection of the system while operating
   1) Leaks
   2) Missing or broken components

Irrigation Association Consumer Bill of Rights

Preamble: IA reminds you to exercise your rights when making an irrigation purchasing decision.

Hiring a Contractor: The right to hire only licensed irrigation contractors in states that require licenses • The right to hire only those contractors certified by IA's nationally recognized Select Certified Program • The right to examine a contractor's past work and to check references.

Insurance: The right to hire a contractor who is insured for liability, workers compensation, and bonded (if applicable).

Workmanship: The right to quality workmanship, as presented in the *Landscape Irrigation Best Management Practices* and *Irrigation, Sixth Edition* • The right to know that all construction codes are being followed and that the proper backflow prevention device has been installed, as per local code.

Contract and Payment: The right to negotiate a contract that includes specific descriptions of work to be done, materials to be used, a written guarantee, and form of payment including payment schedule prior to the start of the project • The right to insist that all changes, additions and deletions to the contract are in writing • The right to redress in court if the contract is broken.

3) Sprinklers out of adjustment
4) Drip irrigation filter and flush valve
5) Others

3.5 Record Drawings

a. Contractor shall designate and maintain a set of construction plans to become the field record drawings and shall record any deviations on a daily basis.
   1) Convert the schematic layout to portray the precise physical location of all piping, sprinklers, valves and other installed components.
   2) Show measurements from fixed or permanent locations such as building corners, man holes, electrical/utility boxes, street lights, etc., to facilitate locating the irrigation components in the field.

b. Upon completion of installation, deliver the field record drawings to the irrigation designer so that the construction documents can be updated to reflect the "as-constructed" condition of the irrigation system.
   - Sprinkler locations
   - Remote control and other valves
   - Sleeving
   - Sensor locations
   - Main line and lateral line routing
   - Routing of wires
   - Drip irrigation flush plugs
   - Major tree locations

c. Contractor shall keep on file a set of construction documents and field record drawings for a minimum of three years.

PG 3: Practice Guideline for Landscape Water Management

The purpose for having an irrigation system is to support the health and viability of the managed landscape by delivering supplemental water to the plants when natural precipitation is not adequate. The irrigation skills and horticultural knowledge required for implementation of best practices come from proper training, experience, and continuous monitoring of the soil-water-plant relationship. Effective landscape water management is one way landscape and irrigation professionals demonstrate responsible stewardship of water resources.

The following guidelines cover the key elements of landscape water management: communication, system maintenance, water budgeting, irrigation scheduling, monitoring and evaluation of water use, irrigation system performance, and landscape health and function. All of these elements are interdependent. Water efficient landscapes are created by appropriate design and installation, but landscape water management and appropriate horticultural practices are what produce and ensure desired results.

The Art and Science of Water Management

Water management can be as simple as turning the water off, but maximizing the potential of a landscape while reducing its water use can be complex. The correct amount of water can be quantified — it is science-based. Proper management, however, is both a science and an art. A skilled water manager has in-depth knowledge of multiple disciplines and may utilize advanced technology to improve water use efficiency.

The Management-Maintenance Connection

Proactive system maintenance will ensure the integrity of the irrigation system. As the landscape matures, and plants mature, the system may require adjustment and enhancement to meet the design intent for the landscape. System maintenance and repair shall seek to support site management objectives. Depending on company structure, one person, or many individuals, may be qualified to perform multiple management functions.

1. Communication and Accountability

The water manager, property owner, and landscape maintenance personnel need to work together to achieve the desired results.

1.1 Communication Among Key Players

a. Property owner/agent should ensure a loop of communication exists with the industry professionals to implement proper site and water management.

b. Property owner/agent and the landscape water manager should engage the water purveyor as a resource. The water purveyor may provide rebates, system evaluations, and water efficiency and conservation initiatives.

c. Recommendations
   1) Establish a regular interval to review contract performance and resource use.
   2) Authorize an amount of money that can be spent to perform unforeseen repairs.
   3) Provide the landscape water manager access to water bills and records for each project.
   4) Develop a drought/water shortage contingency plan.

> ***Key Players***
>
> *Identify who has the authority to implement change.*
>
> *Identify who shall make changes to the irrigation scheduling.*
>
> *Identify relevant regulatory agencies – such as National Pollutant Discharge Elimination System [NPDES] permits.*

1.2 Landscape Water Manager Responsibilities

a. Communication
   1) Water manager shall advise and educate field personnel on their role in managing resources and meeting the owner's expectations (see "Monitoring" section).
   2) Coordinate maintenance activities that will affect water use efficiency.
   3) Determine who has authorization to make changes to the system, the irrigation schedule and emergency service calls.

b. Documentation
   1) Establish a record keeping system.
      - Track weather conditions.
      - Track water usage.
      - Track system maintenance activities (see "Maintenance" section).
   2) Perform on-site observations/verify existing conditions (see "Evaluation" section).
   3) Identify quantitative and qualitative metrics for the site.
   4) Identify and understand special conditions.
      - Site usage (special events, maintenance activities, etc.)
      - Water source and new water sources
      - Drought/water shortage conditions

c. Calculations
   1) Estimate site water usage (see "Section 3: Water Budgeting").
   2) Develop irrigation schedules (see "Scheduling" section).
   3) Develop a system maintenance budget for owner approval.

d. Recommendations
    1) Utilize technology
        - Technology helps the manager do a more thorough and complete job.
        - Online/Internet-based technology allows for more rapid response to problems.
    2) On a new site design, feedback with the designer may be beneficial to improve overall efficiency.

1.3 Outcomes of Communication Tools

a. Accountability of stewardship
    1) Is the correct amount of water being used?
    2) Is the site in compliance with any watering restrictions?
    3) Are other resources being used wisely?

b. Relationship and trust
    1) Increased communication among key parties
    2) Improved corporate image for both owner and contractor

c. Preserve assets in cost-effective strategy
    1) Healthy and vibrant landscapes
    2) Reduction of hardscape maintenance requirements
        - For example, parking lots, sidewalks, roadways, fencing, etc.

2. <u>Maintenance</u>

Regular and routine maintenance of the irrigation system is best accomplished if directed by the irrigation manager to assure that the system operates optimally. The maintenance schedule will ensure that the proper replacement components are used when required, and a plan to respond to unforeseen problems such as vandalism can keep the system working well and minimize wasted water.

2.1 Initial Steps

a. Establish a periodic and routine maintenance schedule to inspect and report performance conditions of the irrigation system to the end-user/owner/owner's representative.

b. Create and post at the controller a station/zone map for ease of system inspection and controller programming. In the absence of an as-built or record drawing, include the location of key components such as controllers, main shutoff valve, isolation valves, remote control valves, filters and any sensors or decoders.

2.2 Periodic Maintenance

a. Review the system components periodically (i.e., annually or as determined by the water manager) to verify the system functionality.

b. Inspect and verify that the backflow prevention device is working correctly and have it tested as required.

c. Inspect and verify that the water supply and pressure meet system operational requirements for optimal system efficiency.

d. Adjust valves for proper flow, closing speed, and operation as needed.

e. Inspect and verify pressure regulators are properly set and adjusted (if installed).

f. Test system wiring for continuity and integrity, and document readings.

g. Establish a winterization protocol (if required based on climate) and a corresponding process for system activation in the spring.

2.3 Ongoing Maintenance

a. Review the system components regularly (i.e., weekly) to verify the efficient operation and uniform distribution of water:
   1) Examine and clean filtration as needed.
   2) Inspect and verify proper operation of the controller. Confirm correct date/time input and functional backup battery where used.
   3) Inspect and verify that sensors used in the irrigation system are working properly.
   4) Inspect and verify that sprinkler heads are operating at recommended pressures and are properly adjusted — nozzle size, arc, radius, level and attitude with respect to slope.
   5) Ensure that plant material is not blocking or interfering with the operation or output of sprinkler heads.
   6) Inspect drip irrigation zones, check the pressure regulator, service the filter and flush laterals to remove silt and foreign matter. Inspect for clogged and missing emitters or damage to the tubing and make repairs.
   7) Repair or replace broken pipe or malfunctioning components and restore the system to its optimal performance capabilities.
   8) Test and adjust all repairs.
      - Complete repairs in a timely manner to support the integrity of the irrigation system.

b. Ensure that replacement parts will perform the same as original equipment.
   1) Sprinklers or nozzles used for system repairs will maintain matched precipitation rate within the hydrozone.
   2) Valves will have the required performance features to meet site conditions such as flow requirements, pressure, and water quality.
   3) Document maintenance procedures and findings.

2.4 Additional Considerations

a. A thorough maintenance program will extend the useful life of the irrigation system.
b. Good horticultural practices and irrigation management are needed to sustain the efficient use of water.
c. Changes and modifications to the irrigation system will be necessary as the landscape matures.

> ***Note:*** *Field personnel should not make changes to equipment without performing a site evaluation and communicating with the water manager.*

3. <u>Water Budgeting</u>

Water budgeting, when used as a landscape water management tool, allows the water manager to plan or anticipate the amount of water required to maintain a healthy and functional landscape (see more in appendix B). The total landscape water requirement is based upon summing the water requirement for each irrigation zone or type of hydrozone in the landscape. The landscape water requirement is based on real-time weather conditions using reference evapotranspiration data adjusted with appropriate plant factors and site rainfall. The manager can utilize meter readings to compare the amount of water applied based on the irrigation scheduling to the calculated water requirements. Adjustments can be made to the schedule as necessary to maintain an acceptable plant appearance within the water allowance. Measured water usage is compared to both the landscape water requirement and the landscape water allowance. It is recommended that this comparison be done at least monthly but more often to determine if adjustments to the irrigation schedule need to be made.

3.1 Landscape Water Requirement

a. The landscape water requirement is determined by summing the water requirement for each irrigation zone or hydrozone in the landscape:

$$LWR = WR_{H1} + WR_{H2} + WR_{H3} + \text{etc.}$$

where

LWR = landscape water requirement {gallons}

WR_{H1} = hydrozone water requirement

b. Estimating the water requirement of a hydrozone uses the following information:

$$WR_H = \frac{((ET_o \times PF) - R_e) \times LA \times 0.623}{IE}$$

where

WR_H = hydrozone water requirement {gallons}

ET_o = evapotranspiration for the time period {in.}

PF = plant factor or turfgrass factor for the hydrozone

R_e = rainfall that is effective within the root zone {in.}

LA = landscape area {ft^2}

0.623 = conversion factor to gallons

IE = irrigation efficiency (an expected efficiency that reflects management skill for scheduling, sprinkler performance and maintenance. It is not the same as distribution uniformity.) For example:

- 90 percent efficiency is about 11 percent more water
- 80 percent efficiency is about 25 percent more water
- 75 percent efficiency is about 33 percent more water
- 70 percent efficiency is about 42 percent more water
- 65 percent efficiency is about 54 percent more water

c. Using water meter readings, determine if the irrigation schedule is applying the correct amount of water by comparing water usage with the amount calculated by the above equation.

3.2 Actions

a. Collect water meter readings and rainfall data for the same period as the estimated landscape water requirement.
b. Compare water usage to the estimated landscape water requirement.
c. Observe plant health and soil moisture conditions.
d. Recommend adjustments to the irrigation schedule if needed.
e. Document results.

3.3 Additional Considerations

a. An additional amount of water will be needed to leach any salt accumulation because of poor water quality.
b. Determine how to maximize the benefit of rainfall to reduce irrigation water.
c. If the site has multiple water sources then use the lowest quality water first.

4. Scheduling

Scheduling landscape irrigation is a process that requires knowledge of the irrigation system's performance characteristics (application rate, distribution uniformity, etc.), soil type and soil water properties, plant root depth, and plant water requirements to determine when and how much water should be replaced. The irrigation schedule is dynamic. It is influenced by rainfall events and seasonal weather patterns. Aspects of irrigation scheduling to maximize efficiency and effectiveness include: total run time for each zone, dividing total run times into multiple cycle-start programs to eliminate or minimize runoff, and the frequency of watering events to minimize plant-water stress. Schedules can be simple single program configurations or more complex multiple programs running stacked in sequence or overlapped running concurrently. The irrigation manager must understand the capabilities of the irrigation system, the soil and soil water properties, variations in root zone depth, solar exposure, the intended purpose and function of the landscape, and the plant water requirements in order to properly determine an irrigation schedule.

Technologies are available that monitor weather or soil moisture conditions and auto-adjust irrigation schedules based on factors that the manager enters into the controller. These controllers can operate with manual schedule adjustments, by percentage of preprogrammed watering times that are based on observed weather changes, or by input from weather, soil moisture, or flow sensors.

4.1 Communication

a. Determine if there are any constraints regarding time of day or day of the week for irrigation.
   1) Use of the site (such as sporting events, mowing schedule, etc.)
   2) Watering restrictions in place by water purveyor
b. Expectations for landscape appearance and water conservation potential
   1) What is the intended level of aesthetic acceptance (stress level)?
   2) Is water use at or below the planned amount?
c. Desired benefits
   1) Water use efficiency
   2) Runoff reduction
   3) A more robust plant health
   4) Sound root system
   5) Reduce weed, disease, and other pest problems

4.2 Documentation

a. If not assigned, determine an appropriate water window for irrigation.
b. Utilize information from site evaluation to be used for scheduling (see "Site Evaluation" section).

4.3 Actions

a. Create an irrigation schedule (see appendix C for more information).
   1) How much water should be applied?
      - Based on weather data and calculated plant water requirement since last irrigation or rainfall
      - Based on allowed soil moisture depletion
      - Based on the soil's ability to move water by capillarity
      - Account for rainfall effectiveness.
      - Does it fit within the landscape water allowance?

2) How long are the run times?
   - Total run time is based on the application rate of the irrigation equipment.
   - Use multiple cycle-starts to prevent runoff.
     (i) Based on soil type, amount of organic matter present and compaction
     (ii) Consider slope and compaction issues.
     (iii) Application rate of the equipment
     (iv) As a rule of thumb when observing runoff, reduce subsequent cycles by 20 percent.
       1. Irrigation equipment has a minimum amount of run time required to effectively apply water to all of the area.
       2. Site observations of runoff collected during evaluation activities provides valuable information to use for calculating cycle-soak scheduling.
   - Does the irrigation schedule fit within the watering window?
     (i) Comply with time of day watering.
3) How often should irrigation be scheduled?
   - Best practice is to irrigate when soil moisture has been depleted to a predetermined threshold that does not contribute to unplanned plant stress.
     (i) Run times remain constant, but the interval between irrigation days changes.
   - Regular interval or designated days of the week.
     (i) The irrigation days are constant but the run time changes to match the amount of water extracted by the plants usually based on modified ET information.
     (ii) Comply with any mandatory watering restrictions for day or days of the week.
4) Special considerations
   - Incorporate personal experience of managing the site with the calculated schedules to assure water use effectiveness.
   - If water sources have high salts, additional irrigation events are needed to flush the harmful salts out of the root zone.

b. Program the controller
   1) Understand the features of the controller to facilitate scheduling and management.
   2) If using smart controller technologies, program the controller with site-specific information such as soils, plant type, irrigation performance, etc.
   3) Set inputs to on-site sensors such as rain shutoff devices, soil moisture sensors, wind sensors, or freeze sensors to inhibit irrigation when it is not conducive for effectiveness.

c. Fine tune controller program
   1) After initially programming a conventional or smart controller
      - Evaluate water content in the root zone using a soil probe.
      - Determine if the zone is too wet, too dry or just right.
   2) Make small incremental adjustments to the controller settings about two weeks apart and retest until the water content in all zones is correct.
   3) Take rain fall into account where appropriate.

Irrigation Effectiveness

Irrigation efficiency is irrigation water beneficially used compared to the amount of irrigation water applied or supplied to the site and is expressed as a percentage.

Distribution uniformity is not a measure of efficiency but rather a way to characterize the evenness of application of water to the planted area and is expressed as a decimal value. In landscape irrigation, this has greatest importance in turfgrass areas.

Irrigation Effectiveness is achieved when the plant water requirement has been supplied without runoff or deep percolation. High distribution uniformity is essential to applying the least amount of water to meet the plant water requirements. Irrigation scheduling is applying the right amount of water at the right time to maintain a healthy landscape.

4.4 Additional Actions

a. Research and utilize irrigation scheduling programs that fit needs.
b. Create a method to adjust irrigation schedules quickly and appropriately.
c. Compare proposed schedule with current schedule (feedback loop) with the original designer/company, where possible.
d. Use soil moisture sensor systems and rain/wind/freeze sensors as bypass devices to suspend irrigation if it is not needed or the weather is not conducive to effective irrigation.

5. <u>Monitoring</u>

The water manager measures water usage and compares it to the estimated water requirement based on current weather conditions. The water manager works alongside with the landscape manager to assesses the overall landscape health and appearance to determine if irrigation is effective by physically checking soil moisture in the root zone and documenting other potential horticultural problems such as nutrient needs, pest management, etc. The irrigation manager makes adjustments to the irrigation schedule as needed to respond to current soil moisture conditions including responding to drought or water shortages. The information collected during ongoing monitoring provides the data to communicate with interested parties and provides the basis for scheduling refinements.

5.1 Communication

a. Are the expectations realistic for what's available (resources, money, water, personnel, restrictions and ordinances, etc.)?
b. Water budget comparison feedback loop
    1) Is the water being used within the expected water budget?
    2) Is the water budget realistic and/or flexible? If the water budget is static, modifications to expectations or management may need to vary.
c. If there are drought or water shortages, is a drought management plan being followed?

5.2 Documentation

a. Obtain past water use records.
   1) Three years of historical usage is recommended.
b. Obtain past weather data.
   1) Use local or nearby weather and ET data from a reliable source.
      - Identify sources of real time weather information; and ET data.
      - Monitor drought conditions.
c. If using on-site harvested or collected water sources, note the following.
   1) Document current water levels in storage tanks.
   2) Water test reports
      - Safety of the water — protect people
      - Quality of the water — not too harm plants
   3) Observe changes to water supply and pressure including pump station functionality.

5.3 Measurement

a. Record water usage.
   1) Monitor water usage frequently and at regular intervals.
      - Read meters on a regular basis (at least monthly during growing season).
      - If meters are not available, measure applied irrigation water using precipitation gauges in the irrigated area.
b. Monitor and record on-site rainfall.
c. Monitor soil conditions and root zone.
   1) Record soil moisture based on soil core sample or sensor reading.
   2) Measure soil compaction with an infiltrometer or similar tool.
   3) Verify root zone depth and soil conditions.
   4) Does the amount of soil moisture within the root zone concur with the expectations?

5.4 Action

a. Observe plant health and record problems identified.
   1) Stress — signs of underwatering
      - Identify indicator plants.
   2) Ponding — signs of saturated soils caused by too much water
   3) Weeds, diseases, and pests
b. Compare calculated water need to water applied to refine your schedule.
c. Compare current water usage using real-time weather data to historical water usage.
d. Compare water usage to forecasted water need to see if it is on track or if corrective action needs to be taken.
e. Develop a soil moisture balance sheet to maximize beneficial rainfall.
f. As plant material matures or changes to the landscape occur, ensure that system modifications are implemented by following the *Landscape Irrigation Best Management Practices* PG1 (design) and PG2 (installation).
   1) Ensure that system modifications are in response to changing site conditions.
   2) In accordance with any applicable local codes or mandates.

5.5 Additional Considerations

a. Install a dedicated irrigation meter or private sub-meter to improve management capability.
b. Explore new technology for monitoring soil conditions and root zone conditions.

6. **Site Evaluation**

An evaluation is a (periodic) review of system performance resulting in adaptive management and initiates recommendations for scheduling, maintenance and monitoring. The irrigation manager inspects the irrigation system to verify that system maintenance procedures are being followed, that equipment is working optimally and that landscape plantings are properly considered when scheduling irrigation. A review of system performance assists the irrigation water manager, owner or end-user to develop an effective irrigation water management plan.

A site evaluation will also forecast requirements for a maturing landscape and assess whether the system in its present configuration will continue to meet the overall objectives of the site.

6.1 Communication

a. Establish the goal and purpose of performing a system evaluation.
b. Share the irrigation system performance results.
c. Make recommendations on changes that might be needed.

6.2 Documentation

a. Water supply
   1) Source(s) (potable, groundwater, rainwater catchment, recycled, etc.)
   2) Expected reliability and availability of alternate water sources.
   3) Verify that backflow prevention has been tested and conforms to code.
b. Soils
   1) Texture (sand, loam, clay)
   2) Preliminary estimate of water holding capacity/infiltration rate
   3) Examine soil profile of the root zone.
   4) Measure depth of root zone.
c. Landscape
   1) List of plant types/turf types
   2) Assess condition of plants — by species and by hydrozone.
d. Review existing irrigation system.
   1) Sprinkler/drip type used in system
   2) Identify irrigation zones.
      - Visual inspection of how well system is operating
        (i) Patterns
        (ii) Wet/dry spots
        (iii) Poor plant health
        (iv) Overall level of system maintenance
      - Do irrigation system zones conform to the identified hydrozones?

6.3 Measurement

a. Water supply
   1) Quality of water (pH, salinity, hardness, etc.)
   2) Quantity (available gpm)
b. Soils
   1) Drainage or compaction problems
   2) Consistency of soil type throughout the site
c. Landscape
   1) Determine water requirement for each plant type.
   2) Measure hydrozone area.
   3) Identify sloped areas.

d. Review existing irrigation system.
   1) Consistency in sprinkler type/nozzle and spacing within a zone
      - Estimated precipitation rate
      - Estimated distribution uniformity
      - Recommend catch can test as needed

6.4 Actions

a. Draw conclusions based on
   1) Soils/drainage/compaction issues.
   2) Irrigation design issues.
      - Improper irrigation zones
      - Improper pressure
      - Poor coverage
      - Overspray
   3) Landscape issues.
   4) Improper plant usage.
   5) Mixed irrigation zones.
   6) Water quality issues.
   7) System maintenance issues including age of components.
   8) System functionality issues.
      - Limited programming capacity, lack of sensors, etc.
   9) System management issue.
      - How well are the system and its components being utilized?

b. Recommendations based on
   1) Most critical issues that need to be addressed.
   2) Return on investment when implementing recommendations.

6.5 Communication Feedback

a. Accountability
   1) Owner
      - Final/financial decision maker
   2) Water manager
      - Develops irrigation schedule/program
      - Develops maintenance tasks and intervals

6.6 Additional Considerations

a. Create a maintenance routine including documenting inspections completed.
b. Assess plant material functionality and or placement within hydrozone.
c. Suggest the testing of the soil and follow recommendations for amendments or other remediation practices such as aeration.
d. Suggest the use of technologies, which will help reduce water use and improve irrigation management.
e. Link original design concept to maintenance tasks. See appendix A for more information about inspecting and/or commissioning an irrigation system.

References

Stetson, L.E. and B.Q. Mecham, eds. 2011. *Irrigation,* 6th ed. Falls Church, VA: Irrigation Association.

Von Bernuth, R.D. and B.Q. Mecham, eds. 2013. *Landscape Irrigation Auditor*, 3rd ed. Falls Church, VA: Irrigation Association.

EPA WaterSense. Refer to the irrigation products and outdoor pages website at www.epa.gov/watersense/.

Source of local historical or current evapotranspiration [ET_o] data (if available): Refer to the "ET Connection" on the Irrigation Association's website at www.irrigation.org/.

Soils data: USDA Natural Resource Conservation Service [NCRS], www.nrcs.org.

Climate data: www.ncdc.noaa.gov.

Rogers, D., F. Lamm, and M. Alam. 2003. Subsurface drip irrigation systems [SDI] water quality assessment guidelines. KSU Publication #2575. Manhattan, KS: Kansas State University. Available at www.ksre.ksu.edu. Accessed 11 March 2014.

Appendix A

Irrigation System Inspection and Commissioning

General:
To assure that the irrigation system has been installed according to plans and specifications, and that the equipment is performing optimally for the site, the system shall be inspected or observed periodically during construction for compliance. Commissioning of the irrigation system is a process whereby the performance of the system can be observed and measurements obtained to verify proper operation and scheduling that meets the contractual obligations. Where required, water usage as the result of scheduling can be compared to the water budget or allowance.

Qualified Inspector/Commissioner:
The person or team doing the inspection and commissioning shall be qualified and demonstrate competence through education, training, experience and/or certification in landscape irrigation and landscape water management. The designer of the system or qualified irrigation manager may be permitted to act as the inspector/commissioner of the landscape irrigation system and shall be objective and independent from the contractor responsible for the work being inspected. Examples of qualified individuals include those who are certified by the Irrigation Association as a certified irrigation designer, certified landscape water manager or certified landscape irrigation auditor. Likewise, professional irrigation consultants are accredited professionals by the American Society of Irrigation Consultants. Other programs may exist that would qualify a person or team to perform inspections and commissioning that would be acceptable to the project owner or the authority having jurisdiction. Possible conflicts of interest shall be disclosed to all parties.

Equipment:
The inspector/commissioner shall have all of the necessary equipment to perform the required inspections and commissioning. The equipment shall be properly calibrated.

Inspection vs. Commissioning:
Inspection is to verify the physical presence of the components and that it has been installed correctly. Commissioning is about verification of functionality and operation.

"Inspect what you expect."

Inspections:

- Field inspections shall take place during and after construction while the contractor is on site to verify that irrigation system components have been properly supplied and installed according to the plans and specifications used for installation. Sometimes this is also referred to as construction observation and could be part of the contracted services with the irrigation designer.
- Record drawings shall be maintained with changes to the approved plans by the contractor and available for periodic inspection as needed.
- See the included example worksheets for performing an inspection and noting acceptance, deficiencies, and if corrections are completed.

Commissioning:

- A commissioning plan shall be developed specifically for the project that will identify the following:
    - The turfgrass areas and related irrigation zones will be observed for proper operation.
    - The specific irrigation zones that shall have performance measurement using catch devices to determine precipitation rate (used for scheduling purposes) and distribution uniformity (if required).
    - **Additional data to be collected**
        - Record meter readings if available as part of the audit process.
        - Operate each drip zone and take pressure readings at the beginning and end of the piping run and record pressure.
        - Verify that controller is properly wired and all pertinent sensors are properly configured and wired into or communicating with the controller.
        - Take ohm readings for each station to verify wiring integrity and record at the controller for future reference.
        - Verify that the irrigation map is consistent with the controller settings for each station.
        - Verify that information about the controller settings/schedule is available at the controller so settings can be restored if necessary.
- Review the current irrigation schedule to
    - Assure the run times are proper for the amount of water needed.
    - Assure that cycle and soak times are utilized to avoid runoff.
    - Where required, compare water usage for current schedule with water budget or allowance based upon real time ET information or soil moisture readings.
    - Verify that information about the controller settings/schedule is available at the controller so settings can be restored if necessary.
- Prepare reports outlining the findings of the commissioning activity within 30 days after verification of the system operation and performance.
    - Precipitation rate for each sprinkler zone/station
    - Quality of the system based upon low-quarter distribution uniformity
    - Deficiencies that need to be corrected
    - Schedule to measure system performance to assure maintenance is being properly completed.
- Other documents:
    - Verify that record drawings of the irrigation system and installation are completed and copies are available to the property owner, property manager and landscape water manager.
    - Operator's manual that includes the basis of design and system operation, equipment list including manufacturer, model number and size and the intent of how the system should be managed including an irrigation system for peak demand showing station run times and watering days (Copies should be available to the property owner, property manager and who will be managing the irrigation system.)
- Contact information for system design, installation and maintenance

Example forms for recording system settings and performance are included to facilitate the inspection and commissioning of the irrigation system.

References

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Auditing Guidelines. Available at: www.irrigation.org/Certification/CLIA/Audit_Requirements.aspx. Accessed 11 March 2014.

ASABE Standards. 2014. X626: Uniformity test for landscape irrigation systems. St. Joseph, MI: ASABE.

Irrigation System Inspection

Project Name________________________ **Location**_____________________________

Date of Inspection____________________ **Inspector**_____________________________

Item Description	Acceptable	Deficient	Corrected
Water Source			
Point of connection size matches plan			
Flow rate matches plan			
Pressure matches plan			
Backflow prevention installed per plan and code			
Water meter / flow meter installed			
Pump station (if applicable) meets plans and specs			
Controller			
Installed per specifications—manufacturer, model, number of stations, grounded properly			
Wiring matches specifications			
Sensors installed and functioning			
Rain shut off device			
Soil moisture sensor(s)			
Flow sensor			
Other (list)			
Controller programmed with date and time			
Irrigation map posted by controller			
Mainline Piping			
Depth of bury meets plans and specs			
Manual valves			
Installed as per plan and specs			
Installed in valve boxes properly set			

Note: If equipment or components are not required, mark as N/A not applicable.

Irrigation Zone/Station Inspection

Project Name________________________ **Location**_____________________________

Date of Inspection____________________ **Inspector**____________________________

Zone/Station Number________

Item Description	Acceptable	Deficient	Corrected
Sprinklers			
Sprinkler type and model match plan			
Sprinkler nozzles are correct			
Sprinkler spacing as per plan			
Sprinkler installed correctly (tilt, distance from hard edge, correct depth)			
Valve			
Valve matches plan, specifications and size			
Valve box properly set and identified			
Valve flow control properly adjusted			
Pressure regulator installed and adjusted			
Wire connections meet specifications			
Piping			
Proper pipe type and size is installed			
Depth of bury meets plan and specs			
Trenches backfilled, compacted and grade level			
Sprinkler Activation			
Sprinklers are adjusted correctly (arc and distance)			
Sprinklers are activated by controller			

Note: Items not installed can be marked N/A for not applicable

Other observations:

Drip Irrigation Inspection

Project Name________________________ **Location**_____________________________

Date of Inspection____________________ **Inspector**____________________________

Zone/Station Number________

Item Description	Acceptable	Deficient	Corrected
Emitters			
Emitter type and model match plan			
Emitter location around plants			
Valve			
Valve matches plan, specifications and size			
Valve box properly set and identified			
Filter installed and serviceable			
Pressure regulator installed			
Wire connections meet specifications			
Piping			
Proper pipe type and size is installed			
Piping is anchored or buried as per specifications			
Flush plugs are installed			
Drip Irrigation Activation			
Drip system is activated by controller			

Note: Items not installed can be marked N/A for not applicable

Other observations:

Appendix B

Landscape Water Budgeting

Landscape water budgeting is a process of comparing the landscape water allowance to the estimated landscape water requirement. The calculation is done using reference evapotranspiration data and an adjustment factor to modify the ET. The adjustment factor should be a reflection of the available water for maintaining the landscape or other goals that are established by the owner of the project or a green initiative such as EPA WaterSense program, LEED, Sustainable Sites or local ordinances such as California's Model Water Efficient Landscape Ordinance. Many programs use the peak demand month (highest reference evapotranspiration and least amount of rainfall) to determine the landscape water allowance, therefore influencing the type of plants that should be used and area and type of turfgrass. Most programs have an extra allowance of water for turfgrass areas used as sports fields. This is becoming a common practice for new landscapes.

Landscape water budgeting can also be used as a management tool to estimate the amount of water the existing landscape requires and then compare to water usage. For most existing landscapes the adjustment factor of 0.80 works well, especially in semi-arid or temperate areas. In the very arid or desert areas, the adjustment factor would likely be less to reflect the available water supply and the type of plants that are used in the landscape.

Landscape water allowance

Following is a general formula for calculating a landscape water allowance for any time period:

$$LWA = ET_o \times AF \times LA \times 0.623 \times LF$$

where

LWA = landscape water allowance {gallons}

ET_o = reference evapotranspiration for the time period {in.}

AF = an ET adjustment factor can be used as follows:

- Normally ≤ 1.0, reflecting water needs of the plant material.
- The maximum water a purveyor or regulatory authority will provide or allow to be used for landscape irrigation. It is typically set between 0.60 and 0.80, depending on the available water supply or to promote conservation.
- A higher adjustment factor should be used for turfgrass areas that are used as sports fields, typically between 0.80 and 1.00 depending on the turf species.

LA = area of the irrigated landscape {ft^2}

0.623 = conversion factor to convert inches to gallons of water.

LF = leaching factor (optional), greater than 1.0 based on water quality and soil type. This is an optional multiplier used in cases of poor water quality (i.e., recycled, surface, or brackish sources).

To estimate the landscape water requirement the calculation would be similar to the following as found in "Practice Guideline 3, Landscape Water Management" and factors in effective rainfall for the site as well as an expected irrigation efficiency to account for less than perfect management and sprinkler system performance.

Landscape water requirement

The landscape water requirement is determined by summing the water requirement for each irrigation zone or hydrozone in the landscape:

$$LWR = WR_{H1} + WR_{H2} + WR_{H3} + \text{etc.}$$

where

LWR = landscape water requirement {gallons}

WR_{H1} = hydrozone water requirement

Estimating the water requirement of a hydrozone uses the following information:

$$WR_H = \frac{((ET_o \times PF) - R_e) \times LA \times 0.623}{IE}$$

where

WR_H = hydrozone water requirement {gallons}

ET_o = evapotranspiration for the time period {in.}

PF = plant factor or turfgrass factor for the hydrozone

R_e = rainfall that is effective within the root zone

LA = landscape area {ft^2}

0.623 = conversion factor to gallons

IE = irrigation efficiency

- 90 percent efficiency is about 11 percent more water
- 80 percent efficiency is about 25 percent more water
- 75 percent efficiency is about 33 percent more water
- 70 percent efficiency is about 42 percent more water
- 65 percent efficiency is about 54 percent more water

To determine the landscape water requirement for the landscape, follow the previous calculation for each type of hydrozone in the landscape and sum the totals for each hydrozone type.

Ultimately the water manager would compare water usage to the allowance. The manager can also determine if the irrigation has been effective by observing the landscape plant material for expected appearance and health.

Appendix C

Basic Landscape Irrigation Scheduling

Irrigation scheduling for landscapes has many complex facets that need to be considered when doing effective irrigation management. Additional information is available in *Irrigation, Sixth Edition*, chapter 13, which discusses the following issues in more detail:

- The landscape water requirement has to account for the water needs of multiple plant types and microclimates found in the landscape compared to an agricultural monoculture not easily influenced by its surroundings.
- Many landscapes deal with disturbed soils that are often imported and layered and require extensive amendment and tillage to make a suitable planting medium.
- Water providers often impose watering restrictions that have to be considered when creating irrigation schedules.
- Irrigating the landscape must meet the purpose or functionality of the landscape as well as maintain an aesthetic appeal.

The irrigation of turfgrass gets perhaps the most attention within a landscape and frequently is the target for many water purveyors when there are water shortages. Therefore, the discussion will be focused on turfgrass irrigation followed by a discussion about the irrigation of other parts of the landscape such as trees, shrubs, ground covers, and flower beds. The principles used to calculate a proper schedule for the turfgrass are applied to all areas of the landscape. Consideration for the amount of water needed by different plants, the density or complexity of the landscape, and the method water is applied to the landscape, are used to create an irrigation schedule.

Landscape Irrigation Scheduling Steps

The steps for creating a landscape irrigation schedule include the following:

- depth of irrigation
- when to irrigate
- how much to irrigate
- how long to irrigate
- restriction or limitation compliance

Depth of Irrigation to Apply

To determine irrigation depth, the user must first identify the soil texture so that the available water-holding capacity of the soil is known. The second step is to determine the depth of the root zone [Z_r]. This step can be aided by using a good soil probe to take several soil cores to observe the presence of roots at various depths. The roots that can be seen by the eye are counted as the root depth and usually more roots are in place to extract water than are visible. Also, it should be remembered that rooting depth can be influenced by irrigation timing. For example, if the area being examined has been watered daily, it may never have developed deeper roots.

The product of available water and root zone depth would be the *total* amount of water held in the root zone. However, only a portion of this is available to the plant because at a certain level of moisture extraction the plant would be stressed. This percentage level separating nonstressed conditions from the commencement of stressed conditions is referred to as allowable depletion. Management allowed depletion [MAD] is a percentage determined by the irrigation manager and depends on soil texture and plant physiology. Generally most practitioners use a MAD of 50 percent or 0.50, which means minimal stress for the plants. If there is managed stress or deficit irrigation is being implemented, the MAD value will be higher.

For most landscapes the goal is to maintain a healthy appearance and functionality of the landscape. Certain levels of stress, then, are acceptable and desirable from a water conservation standpoint. Generally speaking for most landscapes, depleting the available water by 50 percent is acceptable and is called the management allowable depletion. Based upon the soil type and rooting depth of the hydrozone, the following equation can be used to determine a depth of water to be applied:

$$d_{max} = AW \times Z_r \times MAD$$

where

d_{max} = maximum irrigation depth {in., mm}
AW = available water {in., mm}
Z_r = root zone depth {mm}
MAD = management allowed depletion

The concept of MAD is to use the water most readily available to plants first and minimize the amount of stress the plants may experience as they approach the wilting point to get all of the available water. Using MAD also means that irrigation will be more frequent but the amount of water to be applied will be less per irrigation.

When to Irrigate

Allowable depletion is used to determine the frequency of irrigation. During the time of peak water demand such as midsummer, the frequency for turfgrass irrigation could be every two or three days depending on the soil texture and root depth. For extremely arid climates and depending on the type of turfgrass, the irrigation interval could be daily, such as on a golf course. But during the early spring and into fall and winter, the frequency or interval of irrigation could be stretched to every five to seven days, and as the plants go into dormancy it could be every 10 days or more. Even though the interval may seem like an unusually long time, the object of irrigation is to refill the soil reservoir for only the amount that has been extracted. This process is very dependent on plant water demand as plants respond to changing weather.

How Much to Irrigate

The amount of water to apply to the landscape is frequently determined by using evapotranspiration [ET] information and modifying it to better represent the type of plants grown in the landscape as shown in the following equation. Identifying a source of real-time ET information along with appropriate plant or turf factors to modify the reference ET will allow the irrigation manager to create and adjust the irrigation schedules to meet plant water needs. It is best if this is done on a daily basis so as to not exceed the allowable depletion of the soil moisture as previously discussed. Estimating the landscape water requirement or plant water requirement is done as follows:

$$ET_L = ET_o \times K_L$$

where

ET_L = landscape or plant water requirement {in.}
ET_o = grass reference ET information {in.}
K_L = landscape coefficient {decimal}

One approach is to pick a fixed amount of water that would correspond to allowable depletion, 0.50 inch for example. If the plant or turfgrass water requirement is 0.25 inches per day as determined by the use of ET data, the irrigation interval would be every two days. If the plant water requirement is 0.17 inches per day, the frequency of irrigation would be every three days; or if the water need is 0.10 inches per day, irrigation would occur every fifth day. When this approach is used, the number of minutes of run time for each station will remain the same, but the irrigation interval or number of days between irrigation events will change.

Another approach is to use ET information for each day, apply the proper crop or landscape coefficient, and add it up for the number of days in the interval. This would be a fixed-day or interval method. For example if the water requirement for three days were 0.15, 0.22, and 0.19 inches, the amount of water to apply on the irrigation day would be 0.56 inches. The next three-day period could perhaps have a water requirement of 0.47 inches. As can be seen, the amount of water is fluctuating and therefore the number of minutes to apply the water will also need to be changed. When the interval period is fixed because of restrictions that have been imposed by a water utility, or a site has an inadequate water supply, or usage of the site dictates when irrigation can occur such as sporting events, the amount of water to apply will change as the weather changes. Ideally the interval or frequency of irrigation will be close to the managed allowable depletion during peak demand times.

There are a number of other variations for scheduling landscape irrigation, but these two methods, either fixed-amount or fixed-day, are most often used. Typically, in a minimal stress management regime, one-third to one-half of the water within the root zone will be depleted before irrigation or rainfall refills the soil reservoir (maximum allowed depletion). When deficit irrigation practices are implemented, more of the root zone will need to be refilled requiring longer run times. Otherwise, only a part of the root zone will be recharged with water if there are restrictions in place.

Once the amount of water to be applied has been determined, the irrigation manager will subtract any effective rainfall since the previous irrigation to determine if irrigation will still need to be applied or it can be eliminated or postponed for a period of time to maximize the benefit of the rain.

How Long to Irrigate

The number of minutes of run time needed to apply a targeted amount of water is a function of how fast the water is being applied to the landscape, known as precipitation rate or application rate [PR]. Ideally the precipitation rate should be determined from a “catch can” test but otherwise can be determined by the flow rate of the sprinkler nozzle and the spacing pattern of the sprinkler heads in a zone or area. Once the plant water requirement has been determined, the precipitation rate of the sprinklers is used to determine the run time needed to apply that amount of water. This is the number of minutes that will need to be programmed into the controller.

The basic equation for calculating irrigation run times is as follows:

$$RT = \frac{ET_L \times 60}{PR}$$

where

RT = run time for individual station or zone {min}
ET_L = landscape or plant water requirement {in.}
60 = conversion to minutes from hours
PR = precipitation rate of sprinklers {in./h}

Example: Calculating minutes of run time

The reference ET for a given period is 0.62 inches of water, and the species factor used in the landscape coefficient for the grass is 0.70. The sprinkler system applies water at 1.34 inches per hour. How many minutes of run time are required?

Step 1. Determine the plant water requirement [ET_L].

$$ET_L = ET_o \times K_L$$

$$= .62 \times .70$$

$$ET_L = .43 \text{ in.}$$

Step 2. Determine irrigation run time [RT].

$$RT = \frac{ET_L \times 60}{PR}$$

$$= \frac{.43 \text{ in.} \times 60}{1.34 \text{ in./h}}$$

$$RT = 19 \text{ min}$$

Once the run time has been determined, depending on the type of sprinklers being used, the water being applied will be at a rate faster than the intake rate of the soil. In order to mitigate or eliminate runoff, the concept of "cycle-and-soak" is used. This technique will take the number of minutes and break it up into several cycles of shorter duration with a waiting period between cycles to allow the water to infiltrate or percolate into the root zone and then apply some additional water. On coarser soils, one or two cycles are all that might be needed, and on finer soils three or four cycles would be used with adequate soak time. In the above example, using spray sprinklers on a fine or heavy soil might have four irrigation cycles with five minutes of run time duration and 30–40 minutes of soak time between cycle starts. That would amount to 20 minutes of run time, which is roughly equivalent to the calculated run time of 19 minutes.

Controllers

The controllers or timers for turf and landscape irrigation are utilized on small to large landscapes and usually located on-site. Larger landscapes often utilize computerized central control similar to large agricultural operations. Typically the controller is programmed to activate the sprinkler system to apply water to the various zones or areas of the landscape. Controllers can be classified as low, medium, and highly sophisticated. A simple ("low") controller may have many features, but the schedule must be manually adjusted for changing weather conditions. A "medium" sophisticated controller can make some automatic adjustments to the schedule, for example changing the number of minutes of run time of the base schedule by a certain percentage on a monthly basis triggered by the calendar date. Unusual variations of real-time conditions from the historical average will require a manual adjustment. A "highly" sophisticated controller (also known as a "smart" controller) automatically adjusts the frequency of irrigation or the run time or number of cycles based on current growing conditions influenced by the weather, including rainfall. These systems automatically make the adjustments based on the inputs used to describe each hydrozone within the landscape project.

Some controllers are programmed for fixed irrigation intervals with fixed run times that can be changed manually. Other controllers use fixed irrigation intervals or fixed run times, but the run times or intervals are relatively easy to change. The smart controllers (weather-based and/or soil moisture based), once programmed with the correct inputs, will adjust the schedule automatically; however, they may have to comply with mandated restrictions on when to irrigate and how long the irrigation system should run.

For many years, irrigation scheduling was done simply by choosing watering days, start times, and duration of run time with very little regard for knowing the plant water requirements or the amount of water in the soil reservoir. Because of competing demands for water resources, the expectation is to use water wisely and efficiently. New controllers and the use of sensors have enabled managers to improve water management.

References

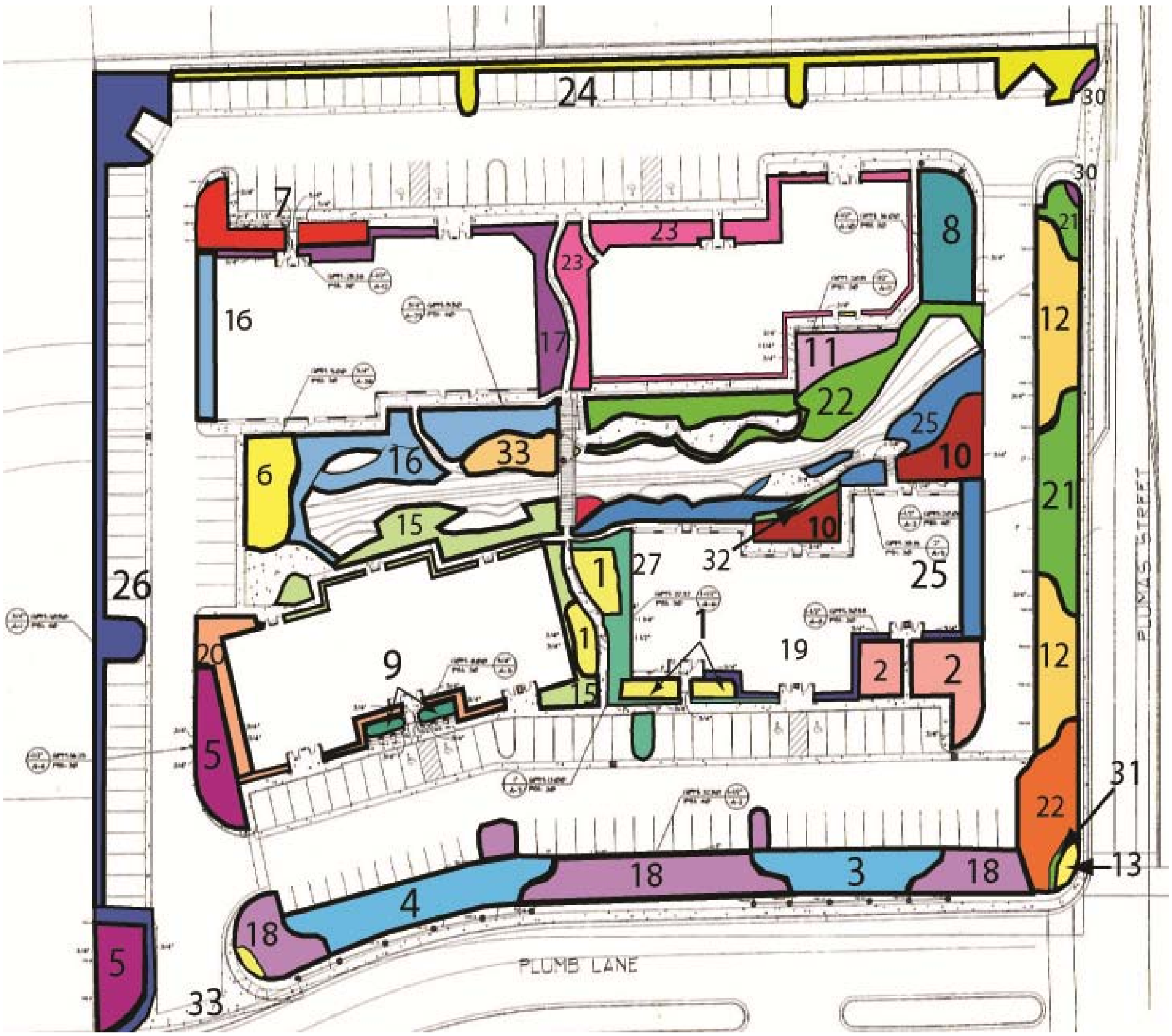
Stetson, L.E. and B.Q. Mecham, eds. 2011. *Irrigation,* 6th ed. Falls Church, VA: Irrigation Association.

Von Bernuth, R.D. and B.Q. Mecham, eds. 2013. *Landscape Irrigation Auditor*, 3rd ed. Falls Church, VA: Irrigation Association.

Appendix D

Controller Map and Station Data Form

An example of a controller map showing by color and controller station number the locations of each irrigation zone. The following station data collection form provides detail about each irrigation zone that can assist in the maintenance and management of the irrigation system.



Station Data Collection Form Example

Job Name:____________________________________ Controller Designation: ____________________________________

Sta.	Plant Type				Soil Type					Slope			Sprinkler						Exposure			
	T	GC	ST	N	S	SL	L	CL	C	FM	MM	SS	SP	GR	IR	SR	RN	DR	SH	PS	FS	RH
1																						
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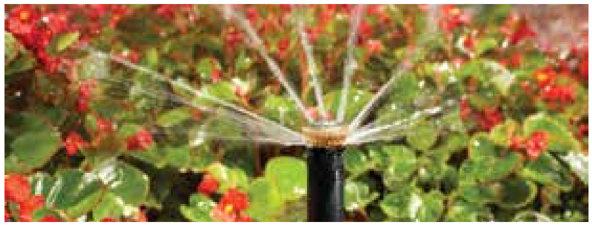
T = Turf/Flowers
GC = Gnd. Cover
ST = Shrub/Tree
N = Natives

S = Sandy
SL = Sandy Loam
L = Loam
CL = Clay Loam
C = Clay

FM = Flat
MM = Med.
SS = Steep

SP = Spray
GR = Gear Rotor
IR = Impact Rotor
SR = Stream Rotor
RN = Rotating Nozzle
DR = Drip

SH = Shade
PS = Part Sun
FS = Full Sun
RH = Reflected


Rain Bird's Guide to:

California Code of Regulations

Title 23. Waters

Division 2. Department of Water Resources

Chapter 2.7. Model Water Efficient Landscape Ordinance

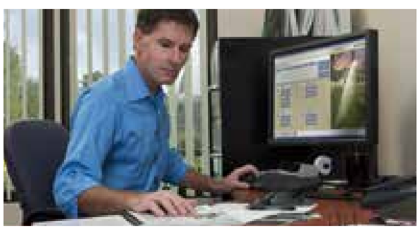


Table of Contents

§ 490. Purpose.

(a) The State Legislature has found:

(1) that the waters of the state are of limited supply and are subject to ever increasing demands;

(2) that the continuation of California's economic prosperity is dependent on the availability of adequate supplies of water for future uses;

(3) that it is the policy of the State to promote the conservation and efficient use of water and to prevent the waste of this valuable resource;

(4) that landscapes are essential to the quality of life in California by providing areas for active and passive recreation and as an enhancement to the environment by cleaning air and water, preventing erosion, offering fire protection, and replacing ecosystems lost to development;

(5) that landscape design, installation, maintenance and management can and should be water efficient;

(6) that Section 2 of Article X of the California Constitution specifies that the right to use water is limited to the amount reasonably required for the beneficial use to be served and the right does not and shall not extend to waste or unreasonable method of use.

(b) Consistent with the legislative findings, the purpose of this model ordinance is to:

(1) promote the values and benefits of landscaping practices that integrate and go beyond the conservation and efficient use of water;

(2) establish a structure for planning, designing, installing, maintaining and managing water efficient landscapes in new construction and rehabilitated projects by encouraging the use of a watershed approach that requires cross-sector collaboration of industry, government and property owners to achieve the many benefits possible;

(3) establish provisions for water management practices and water waste prevention for existing landscapes;

(4) use water efficiently without waste by setting a Maximum Applied Water Allowance as an upper limit for water use and reduce water use to the lowest practical amount;

(5) promote the benefits of consistent landscape ordinances with neighboring local and regional agencies;

(6) encourage local agencies and water purveyors to use economic incentives that promote the efficient use of water, such as implementing a tiered-rate structure; and

(7) encourage local agencies to designate the necessary authority that implements and enforces the provisions of the Model Water Efficient Landscape Ordinance or its local landscape ordinance.

(490) PURPOSE provides background and insight into the direction of the Ordinance.

(c) Landscapes that are planned, designed, installed, managed and maintained with the watershed based approach can improve California's environmental conditions and provide benefits and realize sustainability goals. Such landscapes will make the urban environment resilient in the face of climatic extremes. Consistent with the legislative findings and purpose of the Ordinance, conditions in the urban setting will be improved by:

(1) Creating the conditions to support life in the soil by reducing compaction, incorporating organic matter that increases water retention, and promoting productive plant growth that leads to more carbon storage, oxygen production, shade, habitat and esthetic benefits.

(2) Minimizing energy use by reducing irrigation water requirements, reducing reliance on petroleum based fertilizers and pesticides, and planting climate appropriate shade trees in urban areas.

(3) Conserving water by capturing and reusing rainwater and graywater wherever possible and selecting climate appropriate plants that need minimal supplemental water after establishment.

(4) Protecting air and water quality by reducing power equipment use and landfill disposal trips, selecting recycled and locally sourced materials, and using compost, mulch and efficient irrigation equipment to prevent erosion.

(5) Protecting existing habitat and creating new habitat by choosing local native plants, climate adapted non-natives and avoiding invasive plants. Utilizing integrated pest management with least toxic methods as the first course of action.

§ 490.1. Applicability.

(a) After December 1, 2015, and consistent with Executive Order No. B-29-15, this ordinance shall apply to all of the following landscape projects:

(1) new construction projects with an aggregate landscape area equal to or greater than 500 square feet requiring a building or landscape permit, plan check or design review;

(2) rehabilitated landscape projects with an aggregate landscape area equal to or greater than 2,500 square feet requiring a building or landscape permit, plan check, or design review;

(3) existing landscapes limited to Sections 493, 493.1 and 493.2; and

(4) cemeteries. Recognizing the special landscape management needs of cemeteries, new and rehabilitated cemeteries are limited to Sections 492.4, 492.11, and 492.12; and existing cemeteries are limited to Sections 493, 493.1, and 493.2.

(b) For local land use agencies working together to develop a regional water efficient landscape ordinance, the reporting requirements of this ordinance shall become effective December 1, 2015 and the remainder of this ordinance shall be effective no later than February 1, 2016.

(c) Any project with an aggregate landscape area of 2,500 square feet or less may comply with the performance requirements of this ordinance or conform to the prescriptive measures contained in Appendix D.

(d) For projects using treated or untreated graywater or rainwater captured on site, any lot or parcel within the project that has less than 2500 sq. ft. of landscape and meets the lot or parcel's landscape water requirement (Estimated Total Water Use) entirely with treated or untreated graywater or through stored rainwater captured on site is subject only to Appendix D section (5).

(e) This ordinance does not apply to:

(1) registered local, state or federal historical sites;

(2) ecological restoration projects that do not require a permanent irrigation system;

(3) mined-land reclamation projects that do not require a permanent irrigation system; or

(4) existing plant collections, as part of botanical gardens and arboretums open to the public.

(490.1) APPLICABILITY All projects that require a building or landscape permit, plan check or design review AND meet the following criteria:

- New development projects with an aggregate landscape area ≥ 500 sq. ft.
- Rehabilitated landscape projects with an aggregate landscape area ≥ 2,500 sq. ft.

All projects with aggregate landscape areas ≤ 2,500 sq. ft. can either:

- Comply with the entire ordinance, or
- Conform to prescriptive measures, as outlined in **Appendix D (page 49)**.

SPECIAL NOTES

- Cemeteries and existing landscapes are subject to only certain portions of MWELO.
- Landscapes using recycled water are Special Landscape Areas and get a larger water budget (ETAF = 1.0).

§ 491. Definitions.

The terms used in this ordinance have the meaning set forth below:

(a) **“applied water”** means the portion of water supplied by the irrigation system to the landscape.

(b) **“automatic irrigation controller”** means a timing device used to remotely control valves that operate an irrigation system. Automatic irrigation controllers are able to self-adjust and schedule irrigation events using either evapotranspiration (weather-based) or soil moisture data.

(c) **“backflow prevention device”** means a safety device used to prevent pollution or contamination of the water supply due to the reverse flow of water from the irrigation system.

(d) **“Certificate of Completion”** means the document required under Section 492.9.

(e) **“certified irrigation designer”** means a person certified to design irrigation systems by an accredited academic institution, a professional trade organization or other program such as the US Environmental Protection Agency’s WaterSense irrigation designer certification program and Irrigation Association’s Certified Irrigation Designer program.

(f) **“certified landscape irrigation auditor”** means a person certified to perform landscape irrigation audits by an accredited academic institution, a professional trade organization or other program such as the US Environmental Protection Agency’s WaterSense irrigation auditor certification program and Irrigation Association’s Certified Landscape Irrigation Auditor program.

(g) **“check valve”** or **“anti-drain valve”** means a valve located under a sprinkler head, or other location in the irrigation system, to hold water in the system to prevent drainage from sprinkler heads when the sprinkler is off.

(h) **“common interest developments”** means community apartment projects, condominium projects, planned developments, and stock cooperatives per Civil Code Section 1351.

(i) **“compost”** means the safe and stable product of controlled biologic decomposition of organic materials that is beneficial to plant growth.

(j) **“conversion factor (0.62)”** means the number that converts acre-inches per acre per year to gallons per square foot per year.

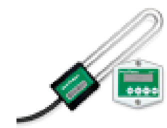
(k) **“distribution uniformity”** means the measure of the uniformity of irrigation water over a defined area.

491. DEFINITIONS.

(b) AUTOMATIC IRRIGATION CONTROLLER Rain Bird offers a full line of smart controllers and sensors.

RESIDENTIAL

Rain Bird® ESP-SMTe



Rain Bird® SMRT-Y Soil Moisture Sensor Kit

COMMERCIAL

Rain Bird® ESP-LXMEF or ESP-LXD with IQ 3.0

Rain Bird® IQ Cloud

On-the-go control from any web-enabled device.

(f) CERTIFIED LANDSCAPE IRRIGATION AUDITOR
Go to **rainbirdservices.com** for information about certification classes.

(g) CHECK VALVE Rain Bird’s built-in Seal-a-Matic™ (SAM) check valve.

Rain Bird® 1800-SAM Series

Rain Bird® 5000-Plus-SAM

(l) **“drip irrigation”** means any non-spray low volume irrigation system utilizing emission devices with a flow rate measured in gallons per hour. Low volume irrigation systems are specifically designed to apply small volumes of water slowly at or near the root zone of plants.

(m) **“ecological restoration project”** means a project where the site is intentionally altered to establish a defined, indigenous, historic ecosystem.

(n) **“effective precipitation”** or **“usable rainfall” (Eppt)** means the portion of total precipitation which becomes available for plant growth.

(o) **“emitter”** means a drip irrigation emission device that delivers water slowly from the system to the soil.

(p) **“established landscape”** means the point at which plants in the landscape have developed significant root growth into the soil. Typically, most plants are established after one or two years of growth.

(q) **“establishment period of the plants”** means the first year after installing the plant in the landscape or the first two years if irrigation will be terminated after establishment. Typically, most plants are established after one or two years of growth. Native habitat mitigation areas and trees may need three to five years for establishment.

(r) **“Estimated Total Water Use” (ETWU)** means the total water used for the landscape as described in Section 492.4.

(s) **“ET adjustment factor” (ETAF)** means a factor of 0.55 for residential areas and 0.45 for non-residential areas, that, when applied to reference evapotranspiration, adjusts for plant factors and irrigation efficiency, two major influences upon the amount of water that needs to be applied to the landscape. The ETAF for new and existing (non-rehabilitated) Special Landscape Areas shall not exceed 1.0. The ETAF for existing non-rehabilitated landscapes is 0.8.

(t) **“evapotranspiration rate”** means the quantity of water evaporated from adjacent soil and other surfaces and transpired by plants during a specified time.

(u) **“flow rate”** means the rate at which water flows through pipes, valves and emission devices, measured in gallons per minute, gallons per hour, or cubic feet per second.

(v) **“flow sensor”** means an inline device installed at the supply point of the irrigation system that produces a repeatable signal proportional to flow rate. Flow sensors must be connected to an automatic irrigation controller, or flow monitor capable of receiving flow signals and operating master valves. This combination flow sensor/controller may also function as a landscape water meter or submeter.

(w) **“friable”** means a soil condition that is easily crumbled or loosely compacted down to a minimum depth per planting material requirements, whereby the root structure of newly planted material will be allowed to spread unimpeded.

(l) DRIP IRRIGATION Rain Bird offers an entire family of drip irrigation.

Point-Source Low-Flow Emitters

XFCV Dripline

(s) ET ADJUSTMENT FACTOR

- Residential ETAF = 0.55
- Non-Residential ETAF = 0.45
- Special Landscape Area (SLA) ETAF = 1.0

See ***Page 12, Definition (ttt)*** *for a definition of SLA.*

(v) FLOW SENSOR Rain Bird offers a complete family of flow sensors. When designed with the **ESP-LXMEF** or **ESP-LXD** controllers or our central control platforms, this also qualifies as a water meter or submeter.

(x) **"Fuel Modification Plan Guideline"** means guidelines from a local fire authority to assist residents and businesses that are developing land or building structures in a fire hazard severity zone.

(y) **"graywater"** means untreated wastewater that has not been contaminated by any toilet discharge, has not been affected by infectious, contaminated, or unhealthy bodily wastes, and does not present a threat from contamination by unhealthful processing, manufacturing, or operating wastes. "Graywater" includes, but is not limited to, wastewater from bathtubs, showers, bathroom washbasins, clothes washing machines, and laundry tubs, but does not include wastewater from kitchen sinks or dishwashers. Health and Safety Code Section 17922.12.

(z) **"hardscapes"** means any durable material (pervious and non-pervious).

(aa) **"hydrozone"** means a portion of the landscaped area having plants with similar water needs and rooting depth. A hydrozone may be irrigated or non-irrigated.

(bb) **"infiltration rate"** means the rate of water entry into the soil expressed as a depth of water per unit of time (e.g., inches per hour).

(cc) **"invasive plant species"** means species of plants not historically found in California that spread outside cultivated areas and can damage environmental or economic resources. Invasive species may be regulated by county agricultural agencies as noxious species. Lists of invasive plants are maintained at the California Invasive Plant Inventory and USDA invasive and noxious weeds database.

(dd) **"irrigation audit"** means an in-depth evaluation of the performance of an irrigation system conducted by a Certified Landscape Irrigation Auditor. An irrigation audit includes, but is not limited to: inspection, system tune-up, system test with distribution uniformity or emission uniformity, reporting overspray or runoff that causes overland flow, and preparation of an irrigation schedule. The audit must be conducted in a manner consistent with the Irrigation Association's Landscape Irrigation Auditor Certification program or other U.S. Environmental Protection Agency "Watersense" labeled auditing program.

(ee) **"irrigation efficiency" (IE)** means the measurement of the amount of water beneficially used divided by the amount of water applied. Irrigation efficiency is derived from measurements and estimates of irrigation system characteristics and management practices. The irrigation efficiency for purposes of this ordinance are 0.75 for overhead spray devices and 0.81 for drip systems..

(ff) **"irrigation survey"** means an evaluation of an irrigation system that is less detailed than an irrigation audit. An irrigation survey includes, but is not limited to: inspection, system test, and written recommendations to improve performance of the irrigation system.

(gg) **"irrigation water use analysis"** means an analysis of water use data based on meter readings and billing data.

(y) GRAYWATER use is encouraged.

(dd) IRRIGATION AUDIT Rain Bird offers the the Irrigation Auditor Course. Go to: **www.rainbirdservices.com**.

The Rain Bird Factory Trained MWELO Expert Course provides the expertise you need to successfully navigate MWELO requirements.

(ee) IRRIGATION EFFICIENCY (IE) Note that irrigation efficiency is preset at **0.75 for overhead spray devices** and **0.81 for drip systems**. No math required.

(hh) **"landscape architect"** means a person who holds a license to practice landscape architecture in the state of California Business and Professions Code, Section 5615.

(ii) **"landscape area"** means all the planting areas, turf areas, and water features in a landscape design plan subject to the Maximum Applied Water Allowance calculation. The landscape area does not include footprints of buildings or structures, sidewalks, driveways, parking lots, decks, patios, gravel or stone walks, other pervious or non-pervious hardscapes, and other non-irrigated areas designated for non-development (e.g., open spaces and existing native vegetation).

(jj) **"landscape contractor"** means a person licensed by the state of California to construct, maintain, repair, install, or subcontract the development of landscape systems.

(kk) **"Landscape Documentation Package"** means the documents required under Section 492.3.

(ll) **"landscape project"** means total area of landscape in a project as defined in "landscape area" for the purposes of this ordinance, meeting requirements under Section 490.1.

(mm) **"landscape water meter"** means an inline device installed at the irrigation supply point that measures the flow of water into the irrigation system and is connected to a totalizer to record water use.

(nn) **"lateral line"** means the water delivery pipeline that supplies water to the emitters or sprinklers from the valve.

(oo) **"local agency"** means a city or county, including a charter city or charter county, that is responsible for adopting and implementing the ordinance. The local agency is also responsible for the enforcement of this ordinance, including but not limited to, approval of a permit and plan check or design review of a project.

(pp) **"local water purveyor"** means any entity, including a public agency, city, county, or private water company that provides retail water service.

(qq) **"low volume irrigation"** means the application of irrigation water at low pressure through a system of tubing or lateral lines and low-volume emitters such as drip, drip lines, and bubblers. Low volume irrigation systems are specifically designed to apply small volumes of water slowly at or near the root zone of plants.

(rr) **"main line"** means the pressurized pipeline that delivers water from the water source to the valve or outlet.

(ss) **"master shut-off valve"** is an automatic valve installed at the irrigation supply point which controls water flow into the irrigation system. When this valve is closed water will not be supplied to the irrigation system. A master valve will greatly reduce any water loss due to a leaky station valve.

(kk) LANDSCAPE DOCUMENT PACKAGE Make sure you review **Section 492.3** for the Landscape Documentation Package.

(mm) LANDSCAPE WATER METER
Rain Bird offers a complete family of central control, commercial-grade controllers and flow sensors that, when designed together, qualify as a water meter or submeter.

(ss) MASTER SHUT-OFF VALVE
Rain Bird offers plastic, brass and combination plastic and brass valves that can be used as master valves.

PEB / PESB Series Valves

EFB -CP

BPES

(tt) **"Maximum Applied Water Allowance" (MAWA)** means the upper limit of annual applied water for the established landscaped area as specified in Section 492.4. It is based upon the area's reference evapotranspiration, the ET Adjustment Factor, and the size of the landscape area. The Estimated Total Water Use shall not exceed the Maximum Applied Water Allowance. Special Landscape Areas, including recreation areas, areas permanently and solely dedicated to edible plants such as orchards and vegetable gardens, and areas irrigated with recycled water are subject to the MAWA with an ETAF not to exceed 1.0. MAWA = (ETo) (0.62) [(ETAF x LA) + ((1-ETAF) x SLA)]

(uu) **"median"** is an area between opposing lanes of traffic that may be unplanted or planted with trees, shrubs, perennials, and ornamental grasses.

(vv) **"microclimate"** means the climate of a small, specific area that may contrast with the climate of the overall landscape area due to factors such as wind, sun exposure, plant density, or proximity to reflective surfaces.

(ww) **"mined-land reclamation projects"** means any surface mining operation with a reclamation plan approved in accordance with the Surface Mining and Reclamation Act of 1975.

(xx) **"mulch"** means any organic material such as leaves, bark, straw, compost, or inorganic mineral materials such as rocks, gravel, or decomposed granite left loose and applied to the soil surface for the beneficial purposes of reducing evaporation, suppressing weeds, moderating soil temperature, and preventing soil erosion.

(yy) **"new construction"** means, for the purposes of this ordinance, a new building with a landscape or other new landscape, such as a park, playground, or greenbelt without an associated building.

(zz) **"non-residential landscape"** means landscapes in commercial, institutional, industrial and public settings that may have areas designated for recreation or public assembly. It also includes portions of common areas of common interest developments with designated recreational areas.

(aaa) **"operating pressure"** means the pressure at which the parts of an irrigation system are designed by the manufacturer to operate.

(bbb) **"overhead sprinkler irrigation systems"** or **"overhead spray irrigation systems"** means systems that deliver water through the air (e.g., spray heads and rotors).

(ccc) **"overspray"** means the irrigation water which is delivered beyond the target area.

(ddd)**"parkway"** means the area between a sidewalk and the curb or traffic lane. It may be planted or unplanted, and with or without pedestrian egress.

(eee) **"permit"** means an authorizing document issued by local agencies for new construction or rehabilitated landscapes.

(fff) **"pervious"** means any surface or material that allows the passage of water through the material and into the underlying soil.

(tt) MAXIMUM APPLIED WATER ALLOWANCE (MAWA) Refer to Appendix B (page 46).

(ggg) **"plant factor"** or **"plant water use factor"** is a factor, when multiplied by ETo, estimates the amount of water needed by plants. For purposes of this ordinance, the plant factor range for very low water use plants is 0 to 0.1, the plant factor range for low water use plants is 0.1 to 0.3, the plant factor range for moderate water use plants is 0.4 to 0.6, and the plant factor range for high water use plants is 0.7 to 1.0. Plant factors cited in this ordinance are derived from the publication "Water Use Classification of Landscape Species". Plant factors may also be obtained from horticultural researchers from academic institutions or professional associations as approved by the California Department of Water Resources (DWR).

(hhh) **"project applicant"** means the individual or entity submitting a Landscape Documentation Package required under Section 492.3, to request a permit, plan check, or design review from the local agency. A project applicant may be the property owner or his or her designee.

(iii) **"rain sensor"** or **"rain sensing shutoff device"** means a component which automatically suspends an irrigation event when it rains.

(jjj) **"record drawing"** or **"as-builts"** means a set of reproducible drawings which show significant changes in the work made during construction and which are usually based on drawings marked up in the field and other data furnished by the contractor.

(kkk) **"recreational area"** means areas, excluding private single family residential areas, designated for active play, recreation or public assembly in parks, sports fields, picnic grounds, amphitheaters or golf course tees, fairways, roughs, surrounds and greens.

(lll) **"recycled water," "reclaimed water,"** or **"treated sewage effluent water"** means treated or recycled waste water of a quality suitable for nonpotable uses such as landscape irrigation and water features. This water is not intended for human consumption.

(mmm) **"reference evapotranspiration"** or **"ETo"** means a standard measurement of environmental parameters which affect the water use of plants. ETo is expressed in inches per day, month, or year as represented in Appendix A , and is an estimate of the evapotranspiration of a large field of four- to seven-inch tall, cool-season grass that is well watered. Reference evapotranspiration is used as the basis of determining the Maximum Applied Water Allowances so that regional differences in climate can be accommodated.

(nnn) **"Regional Water Efficient Landscape Ordinance"** means a local Ordinance adopted by two or more local agencies, water suppliers and other stakeholders for implementing a consistent set of landscape provisions throughout a geographical region. Regional ordinances are strongly encouraged to provide a consistent framework for the landscape industry and applicants to adhere to.

(ggg) PLANT FACTOR or **PLANT WATER USE FACTOR** Derived from Water Use Classification of Landscape Species (WUCOLS)*:

- Very Low Water Use Plants = 0 - 0.1
- Low Water Use Plants = 0.1 - 0.3
- Moderate Water Use Plants = 0.4 - 0.6
- High Water Use Plants = 0.7 - 1.0

** California DWR-approved horticultural researchers, academic institutions or professional associations are alternative sources for plant factors.*

(kkk) RECREATIONAL AREA Areas, excluding private single family residential areas, designated for active play, recreation or public assembly in parks, sports fields, picnic grounds, amphitheaters or golf course tees, fairways, roughs, surrounds and greens.

(nnn) REGIONAL WATER EFFICIENT LANDSCAPE ORDINANCE Check with your local jurisdiction, who may have a stricter local ordinance.

(ooo) **“rehabilitated landscape”** means any relandscaping project that requires a permit, plan check, or design review, meets the requirements of Section 490.1, and the modified landscape area is equal to or greater than 2,500 square feet.

(ppp) **“residential landscape”** means landscapes surrounding single or multi-family homes.

(qqq) **“run off”** means water which is not absorbed by the soil or landscape to which it is applied and flows from the landscape area. For example, run off may result from water that is applied at too great a rate (application rate exceeds infiltration rate) or when there is a slope.

(rrr) **“soil moisture sensing device”** or **“soil moisture sensor”** means a device that measures the amount of water in the soil. The device may also suspend or initiate an irrigation event.

(sss) **“soil texture”** means the classification of soil based on its percentage of sand, silt, and clay.

(ttt) **“Special Landscape Area” (SLA)** means an area of the landscape dedicated solely to edible plants, recreational areas, areas irrigated with recycled water, or water features using recycled water.

(uuu) **“sprinkler head”** or **“spray head”** means a device which delivers water through a nozzle.

(vvv) **“static water pressure”** means the pipeline or municipal water supply pressure when water is not flowing.

(www) **“station”** means an area served by one valve or by a set of valves that operate simultaneously.

(xxx) **“swing joint”** means an irrigation component that provides a flexible, leak-free connection between the emission device and lateral pipeline to allow movement in any direction and to prevent equipment damage.

(yyy) **“submeter”** means a metering device to measure water applied to the landscape that is installed after the primary utility water meter.

(zzz) **“turf”** means a ground cover surface of mowed grass. Annual bluegrass, Kentucky bluegrass, Perennial ryegrass, Red fescue, and Tall fescue are cool-season grasses. Bermudagrass, Kikuyugrass, Seashore Paspalum, St. Augustinegrass, Zoysiagrass, and Buffalo grass are warm-season grasses.

(aaaa) **“valve”** means a device used to control the flow of water in the irrigation system.

(bbbb) **“water conserving plant species”** means a plant species identified as having a very low or low plant factor.

(rrr) SOIL MOISTURE SENSOR Rain Bird® SMRT-Y Soil Moisture Sensor Kit turns any controller into a smart controller.

SMRT-Y

(ttt) SPECIAL LANDSCAPE AREA (SLA) means an area of the landscape dedicated solely to edible plants, recreational areas, areas irrigated with recycled water, or water features using recycled water.

Note **definition (kkk) Recreational Area** for additional details.

(yyy) SUBMETER Rain Bird’s FMD Series Landscape Water Meters are the only irrigation submeters available through traditional irrigation distribution channels.

FMD Series

(cccc) **"water feature"** means a design element where open water performs an aesthetic or recreational function. Water features include ponds, lakes, waterfalls, fountains, artificial streams, spas, and swimming pools (where water is artificially supplied). The surface area of water features is included in the high water use hydrozone of the landscape area. Constructed wetlands used for on-site wastewater treatment or stormwater best management practices that are not irrigated and used solely for water treatment or stormwater retention are not water features and, therefore, are not subject to the water budget calculation.

(dddd) **"watering window"** means the time of day irrigation is allowed.

(eeee) **"WUCOLS"** means the Water Use Classification of Landscape Species published by the University of California Cooperative Extension and the Department of Water Resources 2014.

§ 492. Provisions for New Construction or Rehabilitated Landscapes.

(a) A local agency may designate by mutual agreement, another agency, such as a water purveyor, to implement some or all of the requirements contained in this ordinance. Local agencies may collaborate with water purveyors to define each entity's specific responsibilities relating to this ordinance.

§ 492.1. Compliance with Landscape Documentation Package.

(a) Prior to construction, the local agency shall:

(1) Provide the project applicant with the ordinance and procedures for permits, plan checks or design reviews;

(2) review the Landscape Documentation Package submitted by the project applicant;

(3) approve or deny the Landscape Documentation Package;

(4) issue a permit or approve the plan check or design review for the project applicant; and

(5) upon approval of the Landscape Documentation Package, submit a copy of the Water Efficient Landscape Worksheet to the local water purveyor.

(b) Prior to construction, the project applicant shall:

(1) submit a Landscape Documentation package to the local agency.

(c) Upon approval of the Landscape Documentation package by the local agency, the project applicant shall:

(1) receive a permit or approval fo the plan check or design review and record the date of the permit in the Certificate of Completion;

(2) submit a copy of the approved Landscape Documentation Package along with the record drawings, and any other information to the property owner or his/her designee; and

(3) submit a copy of the Water Efficient Landscape Worksheet to the local water purveyor.

§ 492.2. Penalties.

(a) A local agency may establish and administer penalties to the project applicant for non-compliance with the ordinance to the extent permitted by law.

492.1. COMPLIANCE WITH LANDSCAPE DOCUMENTATION PACKAGE Prior to construction, check with local agency.

§ 492.3. Elements of the Landscape Documentation Package.

(a) The Landscape Documentation Package shall include the following six (6) elements:

(1) project information;

(A) date

(B) project applicant

(C) project address (if available, parcel and/or lot number(s))

(D) total landscape area (square feet)

(E) project type (e.g., new, rehabilitated, public, private, cemetery, homeowner-installed)

(F) water supply type (e.g., potable, recycled, well) and identify the local retail water purveyor if the applicant is not served by a private well

(G) checklist of all documents in Landscape Documentation Package

(H) project contacts to include contact information for the project applicant and property owner

(I) applicant signature and date with statement, "I agree to comply with the requirements of the water efficient landscape ordinance and submit a complete Landscape Documentation Package".

(2) Water Efficient Landscape Worksheet;

(A) hydrozone information table

(B) water budget calculations

1. Maximum Applied Water Allowance (MAWA)

2. Estimated Total Water Use (ETWU)

(3) soil management report;

(4) landscape design plan;

(5) irrigation design plan; and

(6) grading design plan.

492.3. ELEMENTS OF THE LANDSCAPE DOCUMENTATION PACKAGE Must include:

- Project information
- Water efficient landscape worksheet
- Soil management report
- Landscape design plan
- Irrigation design plan
- Grading design plan

§ 492.4. Water Efficient Landscape Worksheet.

(a) A project applicant shall complete the Water Efficient Landscape Worksheet in Appendix B which contains information on the plant factor, irrigation method, irrigation efficiency, and area associated with each hydrozone. Calculations are then made to show that the evapotranspiration adjustment factor (ETAF) for the landscape project does not exceed a factor of 0.55 for residential areas and 0.45 for non-residential areas, exclusive of Special Landscape Areas. The ETAF for a landscape project is based on the plant factors and irrigation methods selected. The Maximum Applied Water Allowance is calculated based on the maximum ETAF allowed (0.55 for residential areas and 0.45 for non-residential areas) and expressed as annual gallons required. The Estimated Total Water Use (ETWU) is calculated based on the plants used and irrigation method selected for the landscape design. ETWU must be below the MAWA.

(1) In calculating the Maximum Applied Water Allowance and Estimated Total Water Use, a project applicant shall use the ETo values from the Reference Evapotranspiration Table in Appendix A. For geographic areas not covered in Appendix A, use data from other cities located nearby in the same reference evapotranspiration zone, as found in the CIMIS Reference Evapotranspiration Zones Map, Department of Water Resources, 1999.

(b) Water budget calculations shall adhere to the following requirements:

(1) The plant factor used shall be from WUCOLS or from horticultural researchers with academic institutions or professional associations as approved by the California Department of Water Resources (DWR). The plant factor ranges from 0 to 0.1 for very low water using plants, 0.1 to 0.3 for low water use plants, from 0.4 to 0.6 for moderate water use plants, and from 0.7 to 1.0 for high water use plants.

(2) All water features shall be included in the high water use hydrozone and temporarily irrigated areas shall be included in the low water use hydrozone.

(3) All Special Landscape Areas shall be identified and their water use calculated as shown in Appendix B.

(4) ETAF for new and existing (non-rehabilitated) Special Landscape Areas shall not exceed 1.0.

492.4. WATER EFFICIENT LANDSCAPE WORKSHEET Refer to **Appendix B (page 46)** for the Water Efficient Landscape Worksheet.

ETo values can be found in the Reference Evapotranspiration Table in **Appendix A (page 36).**

§ 492.5. Soil Management Report.

(a) In order to reduce runoff and encourage healthy plant growth, a soil management report shall be completed by the project applicant, or his/her designee, as follows:

(1) Submit soil samples to a laboratory for analysis and recommendations.

(A) Soil sampling shall be conducted in accordance with laboratory protocol, including protocols regarding adequate sampling depth for the intended plants.

(B) The soil analysis shall include:

1. soil texture;
2. infiltration rate determined by laboratory test or soil texture infiltration rate table;
3. pH;
4. total soluble salts;
5. sodium;
6. percent organic matter; and
7. recommendations.

(C) In projects with multiple landscape installations (i.e. production home developments) a soil sampling rate of 1 in 7 lots or approximately 15% will satisfy this requirement. Large landscape projects shall sample at a rate equivalent to 1 in 7 lots.

(2) The project applicant, or his/her designee, shall comply with one of the following:

(A) If significant mass grading is not planned, the soil analysis report shall be submitted to the local agency as part of the Landscape Documentation Package; or

(B) If significant mass grading is planned, the soil analysis report shall be submitted to the local agency as part of the Certificate of Completion.

(3) The soil analysis report shall be made available, in a timely manner, to the professionals preparing the landscape design plans and irrigation design plans to make any necessary adjustments to the design plans.

(4) The project applicant, or his/her designee, shall submit documentation verifying implementation of soil analysis report recommendations to the local agency with Certificate of Completion.

(492.5) SOIL MANAGEMENT REPORT Note the emphasis on proper soils and analysis.

§ 492.6. Landscape Design Plan.

(a) For the efficient use of water, a landscape shall be carefully designed and planned for the intended function of the project. A landscape design plan meeting the following design criteria shall be submitted as part of the Landscape Documentation Package.

(1) Plant Material

(A) Any plant may be selected for the landscape, providing the Estimated Total Water Use in the landscape area does not exceed the Maximum Applied Water Allowance. Methods to achieve water efficiency shall include one or more of the following:

1. protection and preservation of native species and natural vegetation;
2. selection of water-conserving plant, tree and turf species, especially local native plants;
3. selection of plants based on local climate suitability, disease and pest resistance;
4. selection of trees based on applicable local tree ordinances or tree shading guidelines, and size at maturity as appropriate for the planting area; and
5. selection of plants from local and regional landscape program plant lists.
6. selection of plants from local Fuel Modification Plan Guidelines.

(B) Each hydrozone shall have plant materials with similar water use, with the exception of hydrozones with plants of mixed water use, as specified in Section 492.7(a)(2)(D).

(C) Plants shall be selected and planted appropriately based upon their adaptability to the climatic, geologic, and topographical conditions of the project site. Methods to achieve water efficiency shall include one or more of the following:

1. use the Sunset Western Climate Zone System which takes into account temperature, humidity, elevation, terrain, latitude, and varying degrees of continental and marine influence on local climate;
2. recognize the horticultural attributes of plants (i.e., mature plant size, invasive surface roots) to minimize damage to property or infrastructure [e.g., buildings, sidewalks, power lines]; allow for adequate soil volume for healthy root growth; and
3. consider the solar orientation for plant placement to maximize summer shade and winter solar gain.

(D) Turf is not allowed on slopes greater than 25% where the toe of the slope is adjacent to an impermeable hardscape and where 25% means 1 foot of vertical elevation change for every 4 feet of horizontal length (rise divided by run x 100 = slope percent).

492.6. LANDSCAPE DESIGN PLAN Note the emphasis on plant selection and hydrozones.

(D) TURF Turf is not allowed on slopes greater than 25% where the toe of the slope is adjacent to an impermeable hardscape.

Slope percent = rise divided by run X 100.

(E) High water use plants, characterized by a plant factor of 0.7 to 1.0, are prohibited in street medians.

(F) A landscape design plan for projects in fire-prone areas shall address fire safety and prevention. A defensible space or zone around a building or structure is required per Public Resources Code Section 4291(a) and (b). Avoid fire-prone plant materials and highly flammable mulches. Refer to the local Fuel Modification Plan guidelines.

(G) The use of invasive plant species, such as those listed by the California Invasive Plant Council, is strongly discouraged.

(H) The architectural guidelines of a common interest development, which include community apartment projects, condominiums, planned developments, and stock cooperatives, shall not prohibit or include conditions that have the effect of prohibiting the use of low-water use plants as a group.

(2) Water Features

(A) Recirculating water systems shall be used for water features.

(B) Where available, recycled water shall be used as a source for decorative water features.

(C) Surface area of a water feature shall be included in the high water use hydrozone area of the water budget calculation.

(D) Pool and spa covers are highly recommended.

(3) Soil Preparation, Mulch and Amendments

(A) Prior to the planting of any materials, compacted soils shall be transformed to a friable condition. On engineered slopes, only amended planting holes need meet this requirement.

(B) Soil amendments shall be incorporated according to recommendations of the soil report and what is appropriate for the plants selected (see Section 492.5).

(C) For landscape installations, compost at a rate of a minimum of four cubic yards per 1,000 square feet of permeable area shall be incorporated to a depth of six inches into the soil. Soils with greater than 6% organic matter in the top 6 inches of soil are exempt from adding compost and tilling.

(D) A minimum three inch (3") layer of mulch shall be applied on all exposed soil surfaces of planting areas except in turf areas, creeping or rooting groundcovers, or direct seeding applications where mulch is contraindicated. To provide habitat for beneficial insects and other wildlife, up to 5 % of the landscape area may be left without mulch. Designated insect habitat must be included in the landscape design plan as such.

(E) Stabilizing mulching products shall be used on slopes that meet current engineering standards.

(2) WATER FEATURES must use recirculating water systems and recycled water use is encouraged.

(3) SOIL PREPARATION, MULCH AND AMENDMENTS At least 3" of mulch is required on all exposed soil surfaces, except:

- turf areas
- creeping or rooting groundcovers
- direct seeding applications where mulch is contraindicated.
- in designated insect habitats, up to 5% of the landscaped area.

(F) The mulching portion of the seed/mulch slurry in hydro-seeded applications shall meet the mulching requirement.

(G) Organic mulch materials made from recycled or post-consumer shall take precedence over inorganic materials or virgin forest products unless the recycled post-consumer organic products are not locally available. Organic mulches are not required where prohibited by local Fuel Modification Plan Guidelines or other applicable local ordinances.

(b) The landscape design plan, at a minimum, shall:

(1) delineate and label each hydrozone by number, letter, or other method;

(2) identify each hydrozone as low, moderate, high water, or mixed water use. Temporarily irrigated areas of the landscape shall be included in the low water use hydrozone for the water budget calculation;

(3) identify recreational areas;

(4) identify areas permanently and solely dedicated to edible plants;

(5) identify areas irrigated with recycled water;

(6) identify type of mulch and application depth;

(7) identify soil amendments, type, and quantity;

(8) identify type and surface area of water features;

(9) identify hardscapes (pervious and non-pervious);

(10) identify location, installation details, and 24-hour retention or infiltration capacity of any applicable stormwater best management practices that encourage on-site retention and infiltration of stormwater. Project applicants shall refer to the local agency or regional Water Quality Control Board for information on any applicable stormwater technical requirements. Stormwater best management practices are encouraged in the landscape design plan and examples are provided in Section 492.16.

(11) identify any applicable rain harvesting or catchment technologies as discussed in Section 492.16 and their 24-hour retention or infiltration capacity;

(12) identify any applicable graywater discharge piping, system components and area(s) of distribution;

(13) contain the following statement: "I have complied with the criteria of the ordinance and applied them for the efficient use of water in the landscape design plan"; and

(14) bear the signature of a licensed landscape architect, licensed landscape contractor, or any other person authorized to design a landscape. (See Sections 5500.1, 5615, 5641, 5641.1, 5641.2, 5641.3, 5641.4, 5641.5, 5641.6, 6701, 7027.5 of the Business and Professions Code, Section 832.27 of Title 16 of the California Code of Regulations, and Section 6721 of the Food and Agriculture Code.).

(b) LANDSCAPE DESIGN PLAN
Note the requirements of the landscape design plan.

(b.10) LANDSCAPE DESIGN PLAN
Refer to **section 492.16** for examples of stormwater best management practices.

§ 492.7. Irrigation Design Plan.

(a) This section applies to landscaped areas requiring permanent irrigation, not areas that require temporary irrigation solely for the plant establishment period. For the efficient use of water, an irrigation system shall meet all the requirements listed in this section and the manufacturers' recommendations. The irrigation system and its related components shall be planned and designed to allow for proper installation, management, and maintenance. An irrigation design plan meeting the following design criteria shall be submitted as part of the Landscape Documentation Package.

(1) System

(A) Landscape water meters, defined as either a dedicated water service meter or private submeter, shall be installed for all non-residential irrigated landscapes of 1,000 sq. ft. but not more than 5,000 sq.ft. (the level at which Water Code 535 applies) and residential irrigated landscapes of 5,000 sq. ft. or greater. A landscape water meter may be either:

1. a customer service meter dedicated to landscape use provided by the local water purveyor; or

2. a privately owned meter or submeter.

(B) Automatic irrigation controllers utilizing either evapotranspiration or soil moisture sensor data utilizing non-volatile memory shall be required for irrigation scheduling in all irrigation systems.

(C) If the water pressure is below or exceeds the recommended pressure of the specified irrigation devices, the installation of a pressure regulating device is required to ensure that the dynamic pressure at each emission device is within the manufacturer's recommended pressure range for optimal performance.

1. If the static pressure is above or below the required dynamic pressure of the irrigation system, pressure-regulating devices such as inline pressure regulators, booster pumps, or other devices shall be installed to meet the required dynamic pressure of the irrigation system.

2. Static water pressure, dynamic or operating pressure, and flow reading of the water supply shall be measured at the point of connection. These pressure and flow measurements shall be conducted at the design stage. If the measurements are not available at the design stage, the measurements shall be conducted at installation.

(A) LANDSCAPE WATER METERS Rain Bird offers a complete family of central control, commercial-grade controllers and flow sensors that, when designed together, qualify as a water meter or submeter.

And, Rain Bird's FMD Series Landscape Water Meters are the only irrigation submeters available through traditional irrigation distribution channels.

FMD Series

(B) AUTOMATIC IRRIGATION CONTROLLERS Rain Bird offers a full line of smart controllers, all with non-volatile memory.

ESP-SMTe with Weather Sensor

(C.1) WATER PRESSURE The solutions you need to operate at optimal water pressure.

Use a pump to increase pressure.

D-Series Pump

Use pressure-regulating sprays, rotors and drip filters to decrease pressure.

PRS-SAM Rotors and Sprays

Pressure-Regulating Filter (RBY)

(D) Sensors (rain, freeze, wind, etc.), either integral or auxiliary, that suspend or alter irrigation operation during unfavorable weather conditions shall be required on all irrigation systems, as appropriate for local climatic conditions. Irrigation should be avoided during windy or freezing weather or during rain.

(E) Manual shut-off valves (such as a gate valve, ball valve, or butterfly valve) shall be required, as close as possible to the point of connection of the water supply, to minimize water loss in case of an emergency (such as a main line break) or routine repair.

(F) Backflow prevention devices shall be required to protect the water supply from contamination by the irrigation system. A project applicant shall refer to the applicable local agency code (i.e., public health) for additional backflow prevention requirements.

(G) Flow sensors that detect high flow conditions created by system damage or malfunction are required for all on non-residential landscapes and residential landscapes of 5000 sq. ft. or larger.

(H) Master shut-off valves are required on all projects except landscapes that make use of technologies that allow for the individual control of sprinklers that are individually pressurized in a system equipped with low pressure shut down features.

(I) The irrigation system shall be designed to prevent runoff, low head drainage, overspray, or other similar conditions where irrigation water flows onto non-targeted areas, such as adjacent property, non-irrigated areas, hardscapes, roadways, or structures.

(J) Relevant information from the soil management plan, such as soil type and infiltration rate, shall be utilized when designing irrigation systems.

(K) The design of the irrigation system shall conform to the hydrozones of the landscape design plan.

(L) The irrigation system must be designed and installed to meet, at a minimum, the irrigation efficiency criteria as described in Section 492.4 regarding the Maximum Applied Water Allowance.

(M) All irrigation emission devices must meet the requirements set in the American National Standards Institute (ANSI) standard, American Society of Agricultural and Biological Engineers'/International Code Council's (ASABE/ICC) 802-2014 "Landscape Irrigation Sprinkler and Emitter Standard". All sprinkler heads installed in the landscape must document a distribution uniformity low quarter of 0.65 or higher using the protocol defined in ASABE/ICC 802-2014.

(D) SENSORS Rain Bird offers wireless rain/freeze sensors. Anemometers are also available with central control.

WR2 Wireless Rain/Freeze Sensor

(G) FLOW SENSORS Rain Bird offers a complete family of flow sensors.

(M) IRRIGATION EMISSION DEVICES Rain Bird® HE-VAN, U-Series R-VAN and R-Series nozzles all meet the requirements of ASABE/ICC 802-2014 and achieve DU_{LQ} of 70% or greater.

HE-VAN

U-Series

R-VAN *R-Series*

(N) It is highly recommended that the project applicant or local agency inquire with the local water purveyor about peak water operating demands (on the water supply system) or water restrictions that may impact the effectiveness of the irrigation system.

(O) In mulched planting areas, the use of low volume irrigation is required to maximize water infiltration into the root zone.

(P) Sprinkler heads and other emission devices shall have matched precipitation rates, unless otherwise directed by the manufacturer's recommendations.

(Q) Head to head coverage is recommended. However, sprinkler spacing shall be designed to achieve the highest possible distribution uniformity using the manufacturer's recommendations.

(R) Swing joints or other riser-protection components are required on all risers subject to damage that are adjacent to hardscapes or in high traffic areas of turfgrass.

(S) Check valves or anti-drain valves are required on all sprinkler heads where low point drainage could occur.

(T) Areas less than ten (10) feet in width in any direction shall be irrigated with subsurface irrigation or other means that produces no runoff or overspray.

(U) Overhead irrigation shall not be permitted within 24 inches of any non-permeable surface. Allowable irrigation within the setback from non-permeable surfaces may include drip, drip line, or other low flow non-spray technology. The setback area may be planted or unplanted. The surfacing of the setback may be mulch, gravel, or other porous material. These restrictions may be modified if:

1. the landscape area is adjacent to permeable surfacing and no runoff occurs; or

2. the adjacent non-permeable surfaces are designed and constructed to drain entirely to landscaping; or

3. the irrigation designer specifies an alternative design or technology, as part of the Landscape Documentation Package and clearly demonstrates strict adherence to irrigation system design criteria in Section 492.7 (a)(1)(I). Prevention of overspray and runoff must be confirmed during the irrigation audit.

(O) LOW-VOLUME IRRIGATION is required in mulched planting areas.

(P) MATCHED PRECIPITATION RATES (MPR) Rain Bird offers a full line of matched precipitation rate spray nozzles and MPR nozzles for 5000 Series rotors.

(R) SWING JOINTS Rain Bird has swing assemblies for sprays and turf swing joints for rotors.

(S) CHECK VALVES Rain Bird offers check valves for sprays, rotors and drip.

PRS-SAM Rotors & Sprays

XFCV Dripline

(T) AREAS LESS THAN 10' Use Rain Bird® XFS subsurface drip irrigation for areas less than 10 ft.

XFS Sub-Surface Dripline

(U) 24" SETBACK Rain Bird has a full line of low volume irrigation solutions to irrigate within the 24" setback.

Xeri-Bug™ Emitters

(V) Slopes greater than 25% shall not be irrigated with an irrigation system with a application rate exceeding 0.75 inches per hour. This restriction may be modified if the landscape designer specifies an alternative design or technology, as part of the Landscape Documentation Package, and clearly demonstrates no runoff or erosion will occur. Prevention of runoff and erosion must be confirmed during the irrigation audit.

(2) Hydrozone

(A) Each valve shall irrigate a hydrozone with similar site, slope, sun exposure, soil conditions, and plant materials with similar water use.

(B) Sprinkler heads and other emission devices shall be selected based on what is appropriate for the plant type within that hydrozone.

(C) Where feasible, trees shall be placed on separate valves from shrubs, groundcovers, and turf to facilitate the appropriate irrigation of trees. The mature size and extent of the root zone shall be considered when designing irrigation for the tree.

(D) Individual hydrozones that mix plants of moderate and low water use, or moderate and high water use, may be allowed if:

1. plant factor calculation is based on the proportions of the respective plant water uses and their plant factor; or

2. the plant factor of the higher water using plant is used for calculations.

(E) Individual hydrozones that mix high and low water use plants shall not be permitted.

(F) On the landscape design plan and irrigation design plan, hydrozone areas shall be designated by number, letter, or other designation. On the irrigation design plan, designate the areas irrigated by each valve, and assign a number to each valve. Use this valve number in the Hydrozone Information Table (see Appendix B Section A). This table can also assist with the irrigation audit and programming the controller.

(b) The irrigation design plan, at a minimum, shall contain:

(1) location and size of separate water meters for landscape;

(2) location, type and size of all components of the irrigation system, including controllers, main and lateral lines, valves, sprinkler heads, moisture sensing devices, rain switches, quick couplers, pressure regulators, and backflow prevention devices;

(3) static water pressure at the point of connection to the public water supply;

(4) flow rate (gallons per minute), application rate (inches per hour), and design operating pressure (pressure per square inch) for each station;

(V) SLOPES Rain Bird's low precipitation rate R-VAN, R-Series nozzles and 5000 Series rotors with MPR nozzles have a precipitation rate of 0.6 in./hr.

R-Series

5000 MPR

R-VAN

(C) TREES The Rain Bird® Root Watering System (RWS) enables vital water, oxygen, and nutrients to bypass compacted soil and directly reach tree and shrub root systems.

RWS

(b) IRRIGATION DESIGN PLAN Note the requirements for the irrigation design plan.

(5) recycled water irrigation systems as specified in Section 492.14;

(6) the following statement: "I have complied with the criteria of the ordinance and applied them accordingly for the efficient use of water in the irrigation design plan"; and

(7) the signature of a licensed landscape architect, certified irrigation designer, licensed landscape contractor, or any other person authorized to design an irrigation system. (See Sections 5500.1, 5615, 5641, 5641.1, 5641.2, 5641.3, 5641.4, 5641.5, 5641.6, 6701, 7027.5 of the Business and Professions Code, Section 832.27 of Title 16 of the California Code of Regulations, and Section 6721 of the Food and Agricultural Code.)

§ 492.8. Grading Design Plan.

(a) For the efficient use of water, grading of a project site shall be designed to minimize soil erosion, runoff and water waste. A grading plan shall be submitted as part of the Landscape Documentation Package. A comprehensive grading plan prepared by a civil engineer for other local agency permits satisfies this requirement.

(1) the project applicant shall submit a landscape grading plan that indicates finished configurations and elevations of the landscape area including:

(A) height of graded slopes;

(B) drainage patterns;

(C) pad elevations;

(D) finish grade; and

(E) stormwater retention improvements, if applicable.

(2) To prevent excessive erosion and runoff, it is highly recommended that the project applicants:

(A) grade so that all irrigation and normal rainfall remains within property lines and does not drain on to non-permeable hardscapes;

(B) avoid disruption of natural drainage patterns and undisturbed soil; and

(C) avoild soil compaction in landscape areas.

(3) The grading design plan shall contain the following statement: "I have complied with the criteria of the ordinance and applied them accordingly for the efficient us of water in the grading design plan" and shall bear the signature of a licensed professional as authorized by law.

(492.8) GRADING DESIGN PLAN

Design to minimize soil erosion, runoff and water waste.

§ 492.9. Certificate of Completion.

(a) The Certificate of Completion (see Appendix C for a sample certificate) shall include the following six (6) elements:

(1) project information sheet that contains:

(A) date;

(B) project name;

(C) project applicant name, telephone, and mailing address;

(D) project address and location; and

(E) property owner name, telephone, and mailing address;

(2) certification by either the signer of the landscape design plan, the signer of the irrigation design plan, or the licensed landscape contractor that the landscape project has been installed per the approved Landscape Documentation Package;

(A) where there have been significant changes made in the field during construction, these "as-built" or record drawings shall be included with the certification;

(B) A diagram of the irrigation plan showing hydrozones shall be kept with the irrigation controller for subsequent management purposes.

(3) irrigation scheduling parameters used to set the controller (see Section 492.10);

(4) landscape and irrigation maintenance schedule (see Section 492.11);

(5) irrigation audit report (see Section 492.12); and

(6) soil analysis report, if not submitted with Landscape Documentation Package, and documentation verifying implementation of soil report recommendations (see Section 492.5).

(b) The project applicant shall:

(1) submit the signed Certificate of Completion to the local agency for review;

(2) ensure that copies of the approved Certificate of Completion are submitted to the local water purveyor and property owner or his or her designee.

(c) The local agency shall:

(1) receive the signed Certificate of Completion from the project applicant;

(2) approve or deny the Certificate of Completion. If the Certificate of Completion is denied, the local agency shall provide information to the project applicant regarding reapplication, appeal, or other assistance.

(492.9) CERTIFICATE OF COMPLETION Refer to **Appendix C (page 47)** for a sample of the Certificate of Completion.

§ 492.10. Irrigation Scheduling.

(a) For the efficient use of water, all irrigation schedules shall be developed, managed, and evaluated to utilize the minimum amount of water required to maintain plant health. Irrigation schedules shall meet the following criteria:

(1) Irrigation scheduling shall be regulated by automatic irrigation controllers.

(2) Overhead irrigation shall be scheduled between 8:00 p.m. and 10:00 a.m. unless weather conditions prevent it. If allowable hours of irrigation differ from the local water purveyor, the stricter of the two shall apply. Operation of the irrigation system outside the normal watering window is allowed for auditing and system maintenance.

(3) For implementation of the irrigation schedule, particular attention must be paid to irrigation run times, emission device, flow rate, and current reference evapotranspiration, so that applied water meets the Estimated Total Water Use. Total annual applied water shall be less than or equal to Maximum Applied Water Allowance (MAWA). Actual irrigation schedules shall gbe regulated by automatic irrigation controllers using current reference vapotranspiration data (e.g., CIMIS) or soil moisture sensor data.

(4) Parameters used to set the automatic controller shall be developed and submitted for each of the following:

(A) the plant establishment period;

(B) the established landscape; and

(C) temporarily irrigated areas.

(5) Each irrigation schedule shall consider for each station all of the following that apply:

(A) irrigation interval (days between irrigation);

(B) irrigation run times (hours or minutes per irrigation event to avoid runoff);

(C) number of cycle starts required for each irrigation event to avoid runoff;

(D) amount of applied water scheduled to be applied on a monthly basis;

(E) application rate setting;

(F) root depth setting;

(G) plant type setting;

(H) soil type;

(I) slope factor setting;

(J) shade factor setting; and

(K) irrigation uniformity or efficiency setting.

(492.10) IRRIGATION SCHEDULING Note that the irrigation schedule parameters must be included with the **Certificate of Completion**.

(2) HOURS ALLOWED Schedule irrigation between 8 p.m. and 10 a.m. or local water windows, if stricter.

§ 492.11. Landscape and Irrigation Maintenance Schedule.

(a) Landscapes shall be maintained to ensure water use efficiency. A regular maintenance schedule shall be submitted with the Certificate of Completion.

(b) A regular maintenance schedule shall include, but not be limited to, routine inspection; auditing, adjustment and repair of the irrigation system and its components; aerating and dethatching turf areas; topdressing with compost, replenishing mulch; fertilizing; pruning; weeding in all landscape areas, and removing obstructions to emission devices. Operation of the irrigation system outside the normal watering window is allowed for auditing and system maintenance.

(c) Repair of all irrigation equipment shall be done with the originally installed components or their equivalents or with components with greater efficiency.

(d) A project applicant is encouraged to implement established landscape industry sustainable Best Practices for all landscape maintenance activities.

§ 492.12. Irrigation Audit, Irrigation Survey, and Irrigation Water Use Analysis.

(a) All landscape irrigation audits shall be conducted by a local agency landscape irrigation auditor or a third party certified landscape irrigation auditor. Landscape audits shall not be conducted by the person who designed the landscape or installed the landscape.

(b) In large projects or projects with multiple landscape installations (i.e. production home developments) an auditing rate of 1 in 7 lots or approximately 15% will satisfy this requirement.

(c) For new construction and rehabilitated landscape projects installed after December 1, 2015, as described in Section 490.1:

(1) the project applicant shall submit an irrigation audit report with the Certificate of Completion to the local agency that may include, but is not limited to: inspection, system tune-up, system test with distribution uniformity, reporting overspray or run off that causes overland flow, and preparation of an irrigation schedule, including configuring irrigation controllers with application rate, soil types, plant factors, slope, exposure and any other factors necessary for accurate programming;

(2) the local agency shall administer programs that may include, but not be limited to, irrigation water use analysis, irrigation audits, and irrigation surveys for compliance with the Maximum Applied Water Allowance.

(492.11) LANDSCAPE AND IRRIGATION MAINTENANCE SCHEDULE A landscape and irrigation maintenance schedule must be submitted as part of the **Certification of Completion**.

(492.12) IRRIGATION AUDITS
An irrigation audit report must be submitted with with the **Certificate of Completion**. Landscape audits must be conducted by either a local agency or a third party certified landscape irrigation auditor.

Note: Neither the designer nor the installer may conduct the audit.

(b) PRODUCTION HOMES
Large projects with multiple landscape installations require a 15% audit rate (1 in 7 lots).

§ 492.13. Irrigation Efficiency.

(a) For the purpose of determining Estimated Total Water Use, average irrigation efficiency is assumed to be 0.75 for overhead spray devices and 0.81 for drip system devices.

§ 492.14. Recycled Water.

(a) The installation of recycled water irrigation systems shall allow for the current and future use of recycled water.

(b) All recycled water irrigation systems shall be designed and operated in accordance with all applicable local and State laws.

(c) Landscapes using recycled water are considered Special Landscape Areas. The ET Adjustment Factor for new and existing (non-rehabilitated) Special Landscape Areas shall not exceed 1.0.

§ 492.15. Graywater Systems.

(a) Graywater systems promote the efficient use of water and are encouraged to assist in on-site landscape irrigation. All graywater systems shall conform to the California Plumbing Code (Title 24, Part 5, Chapter 16) and any applicable local ordinance standards. Refer to § 490.1 (d) for the applicability of this ordinance to landscape areas less than 2,500 square feet with the Estimated Total Water Use met entirely by graywater.

(492.13) IRRIGATION EFFICIENCY
You no longer have to calculate irrigation efficiency. It is assumed at: **0.75 for overhead spray devices** and **0.81 for drip system** devices.

(492.14) RECYCLED WATER
Landscapes using recycled water are considered Special Landscape Areas (SLA). SLAs have an ET Adjustment Factor (ETAF) of 1.0.

Rain Bird offers components designed specifically to withstand the harsh conditions found in recycled water, like the RD1800® Series Sprays and PESB-R Series valves.

RD1800 Series Sprays

PESB-R Series Valves

(492.15) GRAYWATER Graywater systems are encouraged. Refer to **section 490.1 (d)** for ordinance applicability to landscape areas < 2,500 sq.ft. with Estimated Total Water Use (ETWU) met entirely by graywater.

§ 492.16. Stormwater Management and Rainwater Retention.

(a) Stormwater management practices minimize runoff and increase infiltration which recharges groundwater and improves water quality. Implementing stormwater best management practices into the landscape and grading design plans to minimize runoff and to increase on-site rainwater retention and infiltration are encouraged.

(b) Project applicants shall refer to the local agency or Regional Water Quality Control Board for information on any applicable stormwater technical requirements.

(c) All planted landscape areas are required to have friable soil to maximize water retention and infiltration. Refer to § 492.6(a)(3).

(d) It is strongly recommended that landscape areas be designed for capture and infiltration capacity that is sufficient to prevent runoff from impervious surfaces (i.e. roof and paved areas) from either: the one inch, 24-hour rain event or (2) the 85th percentile, 24-hour rain event, and/or additional capacity as required by any applicable local, regional, state or federal regulation.

(e) It is recommended that storm water projects incorporate any of the following elements to improve on-site storm water and dry weather runoff capture and use:

- Grade impervious surfaces, such as driveways, during construction to drain to vegetated areas.
- Minimize the area of impervious surfaces such as paved areas, roof and concrete driveways.
- Incorporate pervious or porous surfaces (e.g., gravel, permeable pavers or blocks, pervious or porous concrete) that minimize runoff.
- Direct runoff from paved surfaces and roof areas into planting beds or landscaped areas to maximize site water capture and reuse.
- Incorporate rain gardens, cisterns, and other rain harvesting or catchment systems.
- Incorporate infiltration beds, swales, basins and drywells to capture storm water and dry weather runoff and increase percolation into the soil.
- Consider constructed wetlands and ponds that retain water, equalize excess flow, and filter pollutants.

(492.16) STORMWATER MANAGEMENT Rain Bird offers a complete family of drainage products.

§ 492.17. Public Education.

(a) Publications. Education is a critical component to promote the efficient use of water in landscapes. The use of appropriate principles of design, installation, management and maintenance that save water is encouraged in the community.

(1) A local agency or water supplier/purveyor shall provide information to owners of permitted renovations and new, single-family residential homes regarding the design, installation, management, and maintenance of water efficient landscapes based on a water budget.

(b) Model Homes. All model homes that are landscaped shall use signs and written information to demonstrate the principles of water efficient landscapes described in this ordinance.

(1) Signs shall be used to identify the model as an example of a water efficient landscape featuring elements such as hydrozones, irrigation equipment, and others that contribute to the overall water efficient theme. Signage shall include information about the site water use as designed per the local ordinance; specify who designed and installed the water efficient landscape; and demonstrate low water use approaches to landscaping such as using native plants, graywater systems, and rainwater catchment systems.

(2) Information shall be provided about designing, installing, managing, and maintaining water efficient landscapes.

§ 492.18. Environmental Review.

(a) The local agency must comply with the California Environmental Quality Act (CEQA), as appropriate.

(492.17) PUBLIC EDUCATION

Rain Bird's 25 Ways offers practical, effective tips and advice drawn from the company's 80-plus years of experience in the irrigation industry. Available at **25ways.rainbird.com**, these resources can be used anywhere and by anyone who wants to improve their watering efficiency.

(b) MODEL HOMES SIGNAGE

At **25ways.rainbird.com/saleskit**, you can find customizable signage to promote water efficiency on your projects.

§ 493. Provisions for Existing Landscapes.

(a) A local agency may by mutual agreement, designate another agency, such as a water purveyor, to implement some or all of the requirements contained in this ordinance. Local agencies may collaborate with water purveyors to define each entity's specific responsibilities relating to this ordinance.

§ 493.1. Irrigation Audit, Irrigation Survey, and Irrigation Water Use Analysis.

(a) This section, 493.1, shall apply to all existing landscapes that were installed before December 1, 2015 and are over one acre in size.

(1) For all landscapes in 493.1(a) that have a water meter, the local agency shall administer programs that may include, but not be limited to, irrigation water use analyses, irrigation surveys, and irrigation audits to evaluate water use and provide recommendations as necessary to reduce landscape water use to a level that does not exceed the Maximum Applied Water Allowance for existing landscapes. The Maximum Applied Water Allowance for existing landscapes shall be calculated as: MAWA = (0.8) (ETo)(LA)(0.62).

(2) For all landscapes in 493.1(a), that do not have a meter, the local agency shall administer programs that may include, but not be limited to, irrigation surveys and irrigation audits to evaluate water use and provide recommendations as necessary in order to prevent water waste.

(b) All landscape irrigation audits shall be conducted by a certified landscape irrigation auditor.

§ 493.2. Water Waste Prevention.

(a) Local agencies shall prevent water waste resulting from inefficient landscape irrigation by prohibiting runoff from leaving the target landscape due to low head drainage, overspray, or other similar conditions where water flows onto adjacent property, non-irrigated areas, walks, roadways, parking lots, or structures. Penalties for violation of these prohibitions shall be established locally.

(b) Restrictions regarding overspray and runoff may be modified if:

(1) The landscape area is adjacent to permeable surfacing and no runoff occurs; or

(2) The adjacent non-permeable surfaces are designed and constructed to drain entirely to landscaping.

(493.1) EXISTING LANDSCAPES

Installed before December 1, 2015 and > 1 acre in size.

The Maximum Applied Water Allowance (MAWA) for existing landscapes is MAWA = (0.8)(ETo)(LA)(0.62)

Where ETo is the reference evapotranspiration rate and LA is the landscape area.

§ 494. Effective Precipitation.

(a) A local agency may consider Effective Precipitation (25% of annual precipitation) in tracking water use and may use the following equation to calculate Maximum Applied Water Allowance:

MAWA= (ETo - Eppt) (0.62) [(0.55 x LA) + (0.45 x SLA)] for residential areas.

MAWA= (ETo-Eppt) (0.62) [(0.45 x LA) + (0.55 x SLA)] for non-residential areas.

Note: Authority cited: Section 65595, Government Code. Reference: Section 65596, Government Code.

(494) EFFECTIVE PRECIPITATION

Refer to **Appendix B (page 46)**.

§ 495. Reporting.

(a) Local agencies shall report on implementation and enforcement by December 31, 2015. Local agencies responsible for administering individual ordinances shall report on their updated ordinance, while those agencies developing a regional ordinance shall report on their existing ordinance. Those agencies crafting a regional ordinances shall also report on their new ordinance by March 1, 2016. Subsequently, reporting for all agencies will be due by January 31st of each year. Reports shall be submitted to the Department of Water Resources.

(b) Local agencies are to address the following:

(1) State whether you are adopting a single agency ordinance or a regional agency alliance ordinance, and the date of adoption or anticipated date of adoption.

(2) Define the reporting period. The reporting period shall commence on December 1, 2015 and the end on December 28, 2015. For local agencies crafting regional ordinances with other agencies, there shall be an additional reporting period commencing on February 1, 2016 and ending on February 28, 2016. In subsequent years, all local agency reporting will be for the calendar year.

(3) State if using a locally modified Water Efficient Landscape Ordinance (WELO) or the MWELO. If using a locally modified WELO, how is it different than MWELO, is it at least as efficient as MWELO, and are there any exemptions specified?

(4) State the entity responsible for implementing the ordinance.

(5) State number and types of projects subject to the ordinance during the specified reporting period.

(6) State the total area (in square feet or acres) subject to the ordinance over the reporting period, if available.

(7) Provide the number of new housing starts, new commercial projects, and landscape retrofits during the reporting period.

(8) Describe the procedure for review of projects subject to the ordinance.

(9) Describe actions taken to verify compliance. Is a plan check performed; if so, by what entity? Is a site inspection performed; if so, by what entity? Is a post-installation audit required; if so, by whom?

(10) Describe enforcement measures.

(11) Explain challenges to implementing and enforcing the ordinance.

(12) Describe educational and other needs to properly apply the ordinance.

(495) REPORTING Local agencies have to report annually to the DWR.

(3) LOCAL WATER EFFICIENT LANDSCAPE ORDINANCE (WELO) Check with your local water district to see if there is a stricter local or regional WELO in place.

A list of local water efficient landscape ordinances can be found:

By City:
www.water.ca.gov/wateruseefficiency/landscapeordinance/Model-Water-Efficient-Landscape-Ordinance/Local-Ordinances/

By County:
www.water.ca.gov/wateruseefficiency/landscapeordinance/Model-Water-Efficient-Landscape-Ordinance/Local-Ordinance-By-County/

Note: These are subject to change.

COUNTY AND CITY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL ETo
ALAMEDA													
Fremont	1.5	1.9	3.4	4.7	5.4	6.3	6.7	6.0	4.5	3.4	1.8	1.5	47.0
Livermore	1.2	1.5	2.9	4.4	5.9	6.6	7.4	6.4	5.3	3.2	1.5	0.9	47.2
Oakland	1.5	1.5	2.8	3.9	5.1	5.3	6.0	5.5	4.8	3.1	1.4	0.9	41.8
Oakland Foothills	1.1	1.4	2.7	3.7	5.1	6.4	5.8	4.9	3.6	2.6	1.4	1.0	39.6
Pleasanton	0.8	1.5	2.9	4.4	5.6	6.7	7.4	6.4	4.7	3.3	1.5	1.0	46.2
Union City	1.4	1.8	3.1	4.2	5.4	5.9	6.4	5.7	4.4	3.1	1.5	1.2	44.2
ALPINE													
Markleeville	0.7	0.9	2.0	3.5	5.0	6.1	7.3	6.4	4.4	2.6	1.2	0.5	40.6
AMADOR													
Jackson	1.2	1.5	2.8	4.4	6.0	7.2	7.9	7.2	5.3	3.2	1.4	0.9	48.9
Shanandoah Valley	1.0	1.7	2.9	4.4	5.6	6.8	7.9	7.1	5.2	3.6	1.7	1.0	48.8
BUTTE													
Chico	1.2	1.8	2.9	4.7	6.1	7.4	8.5	7.3	5.4	3.7	1.7	1.0	51.7
Durham	1.1	1.8	3.2	5.0	6.5	7.4	7.8	6.9	5.3	3.6	1.7	1.0	51.1
Gridley	1.2	1.8	3.0	4.7	6.1	7.7	8.5	7.1	5.4	3.7	1.7	1.0	51.9
Oroville	1.2	1.7	2.8	4.7	6.1	7.6	8.5	7.3	5.3	3.7	1.7	1.0	51.5
CALAVERAS													
San Andreas	1.2	1.5	2.8	4.4	6.0	7.3	7.9	7.0	5.3	3.2	1.4	0.7	48.8
COLUSA													
Colusa	1.0	1.7	3.4	5.0	6.4	7.6	8.3	7.2	5.4	3.8	1.8	1.1	52.8
Williams	1.2	1.7	2.9	4.5	6.1	7.2	8.5	7.3	5.3	3.4	1.6	1.0	50.8
CONTRA COSTA													
Brentwood	1.0	1.5	2.9	4.5	6.1	7.1	7.9	6.7	5.2	3.2	1.4	0.7	48.3
Concord	1.1	1.4	2.4	4.0	5.5	5.9	7.0	6.0	4.8	3.2	1.3	0.7	43.4
Courtland	0.9	1.5	2.9	4.4	6.1	6.9	7.9	6.7	5.3	3.2	1.4	0.7	48.0
Martinez	1.2	1.4	2.4	3.9	5.3	5.6	6.7	5.6	4.7	3.1	1.2	0.7	41.8
Moraga	1.2	1.5	3.4	4.2	5.5	6.1	6.7	5.9	4.6	3.2	1.6	1.0	44.9
Pittsburg	1.0	1.5	2.8	4.1	5.6	6.4	7.4	6.4	5.0	3.2	1.3	0.7	45.4
Walnut Creek	0.8	1.5	2.9	4.4	5.6	6.7	7.4	6.4	4.7	3.3	1.5	1.0	46.2
DEL NORTE													
Crescent City	0.5	0.9	2.0	3.0	3.7	3.5	4.3	3.7	3.0	2.0	0.9	0.5	27.7
EL DORADO													
Camino	0.9	1.7	2.5	3.9	5.9	7.2	7.8	6.8	5.1	3.1	1.5	0.9	47.3
FRESNO													
Clovis	1.0	1.5	3.2	4.8	6.4	7.7	8.5	7.3	5.3	3.4	1.4	0.7	51.4
Coalinga	1.2	1.7	3.1	4.6	6.2	7.2	8.5	7.3	5.3	3.4	1.6	0.7	50.9
Firebaugh	1.0	1.8	3.7	5.7	7.3	8.1	8.2	7.2	5.5	3.9	2.0	1.1	55.4
FivePoints	1.3	2.0	4.0	6.1	7.7	8.5	8.7	8.0	6.2	4.5	2.4	1.2	60.4
Fresno	0.9	1.7	3.3	4.8	6.7	7.8	8.4	7.1	5.2	3.2	1.4	0.6	51.1

COUNTY AND CITY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL ETo
FRESNO (cont.)													
Fresno State	0.9	1.6	3.2	5.2	7.0	8.0	8.7	7.6	5.4	3.6	1.7	0.9	53.7
Friant	1.2	1.5	3.1	4.7	6.4	7.7	8.5	7.3	5.3	3.4	1.4	0.7	51.3
Kerman	0.9	1.5	3.2	4.8	6.6	7.7	8.4	7.2	5.3	3.4	1.4	0.7	51.2
Kingsburg	1.0	1.5	3.4	4.8	6.6	7.7	8.4	7.2	5.3	3.4	1.4	0.7	51.6
Mendota	1.5	2.5	4.6	6.2	7.9	8.6	8.8	7.5	5.9	4.5	2.4	1.5	61.7
Orange Cove	1.2	1.9	3.5	4.7	7.4	8.5	8.9	7.9	5.9	3.7	1.8	1.2	56.7
Panoche	1.1	2.0	4.0	5.6	7.8	8.5	8.3	7.3	5.6	3.9	1.8	1.2	57.2
Parlier	1.0	1.9	3.6	5.2	6.8	7.6	8.1	7.0	5.1	3.4	1.7	0.9	52.0
Reedley	1.1	1.5	3.2	4.7	6.4	7.7	8.5	7.3	5.3	3.4	1.4	0.7	51.3
Westlands	0.9	1.7	3.8	6.3	8.0	8.6	8.6	7.8	5.9	4.3	2.1	1.1	58.8
GLENN													
Orland	1.1	1.8	3.4	5.0	6.4	7.5	7.9	6.7	5.3	3.9	1.8	1.4	52.1
Willows	1.2	1.7	2.9	4.7	6.1	7.2	8.5	7.3	5.3	3.6	1.7	1.0	51.3
HUMBOLDT													
Eureka	0.5	1.1	2.0	3.0	3.7	3.7	3.7	3.7	3.0	2.0	0.9	0.5	27.5
Ferndale	0.5	1.1	2.0	3.0	3.7	3.7	3.7	3.7	3.0	2.0	0.9	0.5	27.5
Garberville	0.6	1.2	2.2	3.1	4.5	5.0	5.5	4.9	3.8	2.4	1.0	0.7	34.9
Hoopa	0.5	1.1	2.1	3.0	4.4	5.4	6.1	5.1	3.8	2.4	0.9	0.7	35.6
IMPERIAL													
Brawley	2.8	3.8	5.9	8.0	10.4	11.5	11.7	10.0	8.4	6.2	3.5	2.1	84.2
Calipatria/Mulberry	2.4	3.2	5.1	6.8	8.6	9.2	9.2	8.6	7.0	5.2	3.1	2.3	70.7
El Centro	2.7	3.5	5.6	7.9	10.1	11.1	11.6	9.5	8.3	6.1	3.3	2.0	81.7
Holtville	2.8	3.8	5.9	7.9	10.4	11.6	12.0	10.0	8.6	6.2	3.5	2.1	84.7
Meloland	2.5	3.2	5.5	7.5	8.9	9.2	9.0	8.5	6.8	5.3	3.1	2.2	71.6
Palo Verde II	2.5	3.3	5.7	6.9	8.5	8.9	8.6	7.9	6.2	4.5	2.9	2.3	68.2
Seeley	2.7	3.5	5.9	7.7	9.7	10.1	9.3	8.3	6.9	5.5	3.4	2.2	75.4
Westmoreland	2.4	3.3	5.3	6.9	8.7	9.6	9.6	8.7	6.9	5.0	3.0	2.2	71.4
Yuma	2.5	3.4	5.3	6.9	8.7	9.6	9.6	8.7	6.9	5.0	3.0	2.2	71.6
INYO													
Bishop	1.7	2.7	4.8	6.7	8.2	10.9	7.4	9.6	7.4	4.8	2.5	1.6	68.3
Death Valley Jct	2.2	3.3	5.4	7.7	9.8	11.1	11.4	10.1	8.3	5.4	2.9	1.7	79.1
Independence	1.7	2.7	3.4	6.6	8.5	9.5	9.8	8.5	7.1	3.9	2.0	1.5	65.2
Lower Haiwee Res.	1.8	2.7	4.4	7.1	8.5	9.5	9.8	8.5	7.1	4.2	2.6	1.5	67.6
Oasis	2.7	2.8	5.9	8.0	10.4	11.7	11.6	10.0	8.4	6.2	3.4	2.1	83.1
KERN													
Arvin	1.2	1.8	3.5	4.7	6.6	7.4	8.1	7.3	5.3	3.4	1.7	1.0	51.9
Bakersfield	1.0	1.8	3.5	4.7	6.6	7.7	8.5	7.3	5.3	3.5	1.6	0.9	52.4
Bakersfield/Bonanza	1.2	2.2	3.7	5.7	7.4	8.2	8.7	7.8	5.7	4.0	2.1	1.2	57.9
Bakersfield/Greenlee	1.2	2.2	3.7	5.7	7.4	8.2	8.7	7.8	5.7	4.0	2.1	1.2	57.9

COUNTY AND CITY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL ETo
KERN (cont.)													
Belridge	1.4	2.2	4.1	5.5	7.7	8.5	8.6	7.8	6.0	3.8	2.0	1.5	59.2
Blackwells Corner	1.4	2.1	3.8	5.4	7.0	7.8	8.5	7.7	5.8	3.9	1.9	1.2	56.6
Buttonwillow	1.0	1.8	3.2	4.7	6.6	7.7	8.5	7.3	5.4	3.4	1.5	0.9	52.0
China Lake	2.1	3.2	5.3	7.7	9.2	10.0	11.0	9.8	7.3	4.9	2.7	1.7	74.8
Delano	0.9	1.8	3.4	4.7	6.6	7.7	8.5	7.3	5.4	3.4	1.4	0.7	52.0
Famoso	1.3	1.9	3.5	4.8	6.7	7.6	8.0	7.3	5.5	3.5	1.7	1.3	53.1
Grapevine	1.3	1.8	3.1	4.4	5.6	6.8	7.6	6.8	5.9	3.4	1.9	1.0	49.5
Inyokern	2.0	3.1	4.9	7.3	8.5	9.7	11.0	9.4	7.1	5.1	2.6	1.7	72.4
Isabella Dam	1.2	1.4	2.8	4.4	5.8	7.3	7.9	7.0	5.0	3.2	1.7	0.9	48.4
Lamont	1.3	2.4	4.4	4.6	6.5	7.0	8.8	7.6	5.7	3.7	1.6	0.8	54.4
Lost Hills	1.6	2.2	3.7	5.1	6.8	7.8	8.7	7.8	5.7	4.0	2.1	1.6	57.1
McFarland/Kern	1.2	2.1	3.7	5.6	7.3	8.0	8.3	7.4	5.6	4.1	2.0	1.2	56.5
Shafter	1.0	1.7	3.4	5.0	6.6	7.7	8.3	7.3	5.4	3.4	1.5	0.9	52.1
Taft	1.3	1.8	3.1	4.3	6.2	7.3	8.5	7.3	5.4	3.4	1.7	1.0	51.2
Tehachapi	1.4	1.8	3.2	5.0	6.1	7.7	7.9	7.3	5.9	3.4	2.1	1.2	52.9
KINGS													
Caruthers	1.6	2.5	4.0	5.7	7.8	8.7	9.3	8.4	6.3	4.4	2.4	1.6	62.7
Corcoran	1.6	2.2	3.7	5.1	6.8	7.8	8.7	7.8	5.7	4.0	2.1	1.6	57.1
Hanford	0.9	1.5	3.4	5.0	6.6	7.7	8.3	7.2	5.4	3.4	1.4	0.7	51.5
Kettleman	1.1	2.0	4.0	6.0	7.5	8.5	9.1	8.2	6.1	4.5	2.2	1.1	60.2
Lemoore	0.9	1.5	3.4	5.0	6.6	7.7	8.3	7.3	5.4	3.4	1.4	0.7	51.7
Stratford	0.9	1.9	3.9	6.1	7.8	8.6	8.8	7.7	5.9	4.1	2.1	1.0	58.7
LAKE													
Lakeport	1.1	1.3	2.6	3.5	5.1	6.0	7.3	6.1	4.7	2.9	1.2	0.9	42.8
Lower Lake	1.2	1.4	2.7	4.5	5.3	6.3	7.4	6.4	5.0	3.1	1.3	0.9	45.4
LASSEN													
Buntingville	1.0	1.7	3.5	4.9	6.2	7.3	8.4	7.5	5.4	3.4	1.5	0.9	51.8
Ravendale	0.6	1.1	2.3	4.1	5.6	6.7	7.9	7.3	4.7	2.8	1.2	0.5	44.9
Susanville	0.7	1.0	2.2	4.1	5.6	6.5	7.8	7.0	4.6	2.8	1.2	0.5	44.0
LOS ANGELES													
Burbank	2.1	2.8	3.7	4.7	5.1	6.0	6.6	6.7	5.4	4.0	2.6	2.0	51.7
Claremont	2.0	2.3	3.4	4.6	5.0	6.0	7.0	7.0	5.3	4.0	2.7	2.1	51.3
El Dorado	1.7	2.2	3.6	4.8	5.1	5.7	5.9	5.9	4.4	3.2	2.2	1.7	46.3
Glendale	2.0	2.2	3.3	3.8	4.7	4.8	5.7	5.6	4.3	3.3	2.2	1.8	43.7
Glendora	2.0	2.5	3.6	4.9	5.4	6.1	7.3	6.8	5.7	4.2	2.6	2.0	53.1
Gorman	1.6	2.2	3.4	4.6	5.5	7.4	7.7	7.1	5.9	3.6	2.4	1.1	52.4
Hollywood Hills	2.1	2.2	3.8	5.4	6.0	6.5	6.7	6.4	5.2	3.7	2.8	2.1	52.8
Lancaster	2.1	3.0	4.6	5.9	8.5	9.7	11.0	9.8	7.3	4.6	2.8	1.7	71.1
Long Beach	1.8	2.1	3.3	3.9	4.5	4.3	5.3	4.7	3.7	2.8	1.8	1.5	39.7

COUNTY AND CITY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL ETo
LOS ANGELES (cont.)													
Los Angeles	2.2	2.7	3.7	4.7	5.5	5.8	6.2	5.9	5.0	3.9	2.6	1.9	50.1
Monrovia	2.2	2.3	3.8	4.3	5.5	5.9	6.9	6.4	5.1	3.2	2.5	2.0	50.2
Palmdale	2.0	2.6	4.6	6.2	7.3	8.9	9.8	9.0	6.5	4.7	2.7	2.1	66.2
Pasadena	2.1	2.7	3.7	4.7	5.1	6.0	7.1	6.7	5.6	4.2	2.6	2.0	52.3
Pearblossom	1.7	2.4	3.7	4.7	7.3	7.7	9.9	7.9	6.4	4.0	2.6	1.6	59.9
Pomona	1.7	2.0	3.4	4.5	5.0	5.8	6.5	6.4	4.7	3.5	2.3	1.7	47.5
Redondo Beach	2.2	2.4	3.3	3.8	4.5	4.7	5.4	4.8	4.4	2.8	2.4	2.0	42.6
San Fernando	2.0	2.7	3.5	4.6	5.5	5.9	7.3	6.7	5.3	3.9	2.6	2.0	52.0
Santa Clarita	2.8	2.8	4.1	5.6	6.0	6.8	7.6	7.8	5.8	5.2	3.7	3.2	61.5
Santa Monica	1.8	2.1	3.3	4.5	4.7	5.0	5.4	5.4	3.9	3.4	2.4	2.2	44.2
MADERA													
Chowchilla	1.0	1.4	3.2	4.7	6.6	7.8	8.5	7.3	5.3	3.4	1.4	0.7	51.4
Madera	0.9	1.4	3.2	4.8	6.6	7.8	8.5	7.3	5.3	3.4	1.4	0.7	51.5
Raymond	1.2	1.5	3.0	4.6	6.1	7.6	8.4	7.3	5.2	3.4	1.4	0.7	50.5
MARIN													
Black Point	1.1	1.7	3.0	4.2	5.2	6.2	6.6	5.8	4.3	2.8	1.3	0.9	43.0
Novato	1.3	1.5	2.4	3.5	4.4	6.0	5.9	5.4	4.4	2.8	1.4	0.7	39.8
Point San Pedro	1.1	1.7	3.0	4.2	5.2	6.2	6.6	5.8	4.3	2.8	1.3	0.9	43.0
San Rafael	1.2	1.3	2.4	3.3	4.0	4.8	4.8	4.9	4.3	2.7	1.3	0.7	35.8
MARIPOSA													
Coulterville	1.1	1.5	2.8	4.4	5.9	7.3	8.1	7.0	5.3	3.4	1.4	0.7	48.8
Mariposa	1.1	1.5	2.8	4.4	5.9	7.4	8.2	7.1	5.0	3.4	1.4	0.7	49.0
Yosemite Village	0.7	1.0	2.3	3.7	5.1	6.5	7.1	6.1	4.4	2.9	1.1	0.6	41.4
MENDOCINO													
Fort Bragg	0.9	1.3	2.2	3.0	3.7	3.5	3.7	3.7	3.0	2.3	1.2	0.7	29.0
Hopland	1.1	1.3	2.6	3.4	5.0	5.9	6.5	5.7	4.5	2.8	1.3	0.7	40.9
Point Arena	1.0	1.3	2.3	3.0	3.7	3.9	3.7	3.7	3.0	2.3	1.2	0.7	29.6
Sanel Valley	1.0	1.6	3.0	4.6	6.0	7.0	8.0	7.0	5.2	3.4	1.4	0.9	49.1
Ukiah	1.0	1.3	2.6	3.3	5.0	5.8	6.7	5.9	4.5	2.8	1.3	0.7	40.9
MERCED													
Kesterson	0.9	1.7	3.4	5.5	7.3	8.2	8.6	7.4	5.5	3.8	1.8	0.9	55.1
Los Banos	1.0	1.5	3.2	4.7	6.1	7.4	8.2	7.0	5.3	3.4	1.4	0.7	50.0
Merced	1.0	1.5	3.2	4.7	6.6	7.9	8.5	7.2	5.3	3.4	1.4	0.7	51.5
MODOC													
Modoc/Alturas	0.9	1.4	2.8	3.7	5.1	6.2	7.5	6.6	4.6	2.8	1.2	0.7	43.2
MONO													
Bridgeport	0.7	0.9	2.2	3.8	5.5	6.6	7.4	6.7	4.7	2.7	1.2	0.5	43.0
MONTEREY													
Arroyo Seco	1.5	2.0	3.7	5.4	6.3	7.3	7.2	6.7	5.0	3.9	2.0	1.6	52.6

COUNTY AND CITY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL ETo
MONTEREY (cont.)													
Castroville	1.4	1.7	3.0	4.2	4.6	4.8	4.0	3.8	3.0	2.6	1.6	1.4	36.2
Gonzales	1.3	1.7	3.4	4.7	5.4	6.3	6.3	5.9	4.4	3.4	1.9	1.3	45.7
Greenfield	1.8	2.2	3.4	4.8	5.6	6.3	6.5	6.2	4.8	3.7	2.4	1.8	49.5
King City	1.7	2.0	3.4	4.4	4.4	5.6	6.1	6.7	6.5	5.2	2.2	1.3	49.6
King City-Oasis Rd.	1.4	1.9	3.6	5.3	6.5	7.3	7.4	6.8	5.1	4.0	2.0	1.5	52.7
Long Valley	1.5	1.9	3.2	4.1	5.8	6.5	7.3	6.7	5.3	3.6	2.0	1.2	49.1
Monterey	1.7	1.8	2.7	3.5	4.0	4.1	4.3	4.2	3.5	2.8	1.9	1.5	36.0
Pajaro	1.8	2.2	3.7	4.8	5.3	5.7	5.6	5.3	4.3	3.4	2.4	1.8	46.1
Salinas	1.6	1.9	2.7	3.8	4.8	4.7	5.0	4.5	4.0	2.9	1.9	1.3	39.1
Salinas North	1.2	1.5	2.9	4.1	4.6	5.2	4.5	4.3	3.2	2.8	1.5	1.2	36.9
San Ardo	1.0	1.7	3.1	4.5	5.9	7.2	8.1	7.1	5.1	3.1	1.5	1.0	49.0
San Juan	1.8	2.1	3.4	4.6	5.3	5.7	5.5	4.9	3.8	3.2	2.2	1.9	44.2
Soledad	1.7	2.0	3.4	4.4	5.5	5.4	6.5	6.2	5.2	3.7	2.2	1.5	47.7
NAPA													
Angwin	1.8	1.9	3.2	4.7	5.8	7.3	8.1	7.1	5.5	4.5	2.9	2.1	54.9
Carneros	0.8	1.5	3.1	4.6	5.5	6.6	6.9	6.2	4.7	3.5	1.4	1.0	45.8
Oakville	1.0	1.5	2.9	4.7	5.8	6.9	7.2	6.4	4.9	3.5	1.6	1.2	47.7
St Helena	1.2	1.5	2.8	3.9	5.1	6.1	7.0	6.2	4.8	3.1	1.4	0.9	44.1
Yountville	1.3	1.7	2.8	3.9	5.1	6.0	7.1	6.1	4.8	3.1	1.5	0.9	44.3
NEVADA													
Grass Valley	1.1	1.5	2.6	4.0	5.7	7.1	7.9	7.1	5.3	3.2	1.5	0.9	48.0
Nevada City	1.1	1.5	2.6	3.9	5.8	6.9	7.9	7.0	5.3	3.2	1.4	0.9	47.4
ORANGE													
Irvine	2.2	2.5	3.7	4.7	5.2	5.9	6.3	6.2	4.6	3.7	2.6	2.3	49.6
Laguna Beach	2.2	2.7	3.4	3.8	4.6	4.6	4.9	4.9	4.4	3.4	2.4	2.0	43.2
Santa Ana	2.2	2.7	3.7	4.5	4.6	5.4	6.2	6.1	4.7	3.7	2.5	2.0	48.2
PLACER													
Auburn	1.2	1.7	2.8	4.4	6.1	7.4	8.3	7.3	5.4	3.4	1.6	1.0	50.6
Blue Canyon	0.7	1.1	2.1	3.4	4.8	6.0	7.2	6.1	4.6	2.9	0.9	0.6	40.5
Colfax	1.1	1.5	2.6	4.0	5.8	7.1	7.9	7.0	5.3	3.2	1.4	0.9	47.9
Roseville	1.1	1.7	3.1	4.7	6.2	7.7	8.5	7.3	5.6	3.7	1.7	1.0	52.2
Soda Springs	0.7	0.7	1.8	3.0	4.3	5.3	6.2	5.5	4.1	2.5	0.7	0.7	35.4
Tahoe City	0.7	0.7	1.7	3.0	4.3	5.4	6.1	5.6	4.1	2.4	0.8	0.6	35.5
Truckee	0.7	0.7	1.7	3.2	4.4	5.4	6.4	5.7	4.1	2.4	0.8	0.6	36.2
PLUMAS													
Portola	0.7	0.9	1.9	3.5	4.9	5.9	7.3	5.9	4.3	2.7	0.9	0.5	39.4
Quincy	0.7	0.9	2.2	3.5	4.9	5.9	7.3	5.9	4.4	2.8	1.2	0.5	40.2

COUNTY AND CITY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL ETo
RIVERSIDE													
Beaumont	2.0	2.3	3.4	4.4	6.1	7.1	7.6	7.9	6.0	3.9	2.6	1.7	55.0
Blythe	2.4	3.3	5.3	6.9	8.7	9.6	9.6	8.7	6.9	5.0	3.0	2.2	71.4
Cathedral City	1.6	2.2	3.7	5.1	6.8	7.8	8.7	7.8	5.7	4.0	2.1	1.6	57.1
Coachella	2.9	4.4	6.2	8.4	10.5	11.9	12.3	10.1	8.9	6.2	3.8	2.4	88.1
Desert Center	2.9	4.1	6.4	8.5	11.0	12.1	12.2	11.1	9.0	6.4	3.9	2.6	90.0
Elsinore	2.1	2.8	3.9	4.4	5.9	7.1	7.6	7.0	5.8	3.9	2.6	1.9	55.0
Indio	3.1	3.6	6.5	8.3	10.5	11.0	10.8	9.7	8.3	5.9	3.7	2.7	83.9
La Quinta	2.4	2.8	5.2	6.5	8.3	8.7	8.5	7.9	6.5	4.5	2.7	2.2	66.2
Mecca	2.6	3.3	5.7	7.2	8.6	9.0	8.8	8.2	6.8	5.0	3.2	2.4	70.8
Oasis	2.9	3.3	5.3	6.1	8.5	8.9	8.7	7.9	6.9	4.8	2.9	2.3	68.4
Palm Desert	2.5	3.4	5.3	6.9	8.7	9.6	9.6	8.7	6.9	5.0	3.0	2.2	71.6
Palm Springs	2.0	2.9	4.9	7.2	8.3	8.5	11.6	8.3	7.2	5.9	2.7	1.7	71.1
Rancho California	1.8	2.2	3.4	4.8	5.6	6.3	6.5	6.2	4.8	3.7	2.4	1.8	49.5
Rancho Mirage	2.4	3.3	5.3	6.9	8.7	9.6	9.6	8.7	6.9	5.0	3.0	2.2	71.4
Ripley	2.7	3.3	5.6	7.2	8.7	8.7	8.4	7.6	6.2	4.6	2.8	2.2	67.8
Salton Sea North	2.5	3.3	5.5	7.2	8.8	9.3	9.2	8.5	6.8	5.2	3.1	2.3	71.7
Temecula East II	2.3	2.4	4.1	4.9	6.4	7.0	7.8	7.4	5.7	4.1	2.6	2.2	56.7
Thermal	2.4	3.3	5.5	7.6	9.1	9.6	9.3	8.6	7.1	5.2	3.1	2.1	72.8
Riverside UC	2.5	2.9	4.2	5.3	5.9	6.6	7.2	6.9	5.4	4.1	2.9	2.6	56.4
Winchester	2.3	2.4	4.1	4.9	6.4	6.9	7.7	7.5	6.0	3.9	2.6	2.1	56.8
SACRAMENTO													
Fair Oaks	1.0	1.6	3.4	4.1	6.5	7.5	8.1	7.1	5.2	3.4	1.5	1.0	50.5
Sacramento	1.0	1.8	3.2	4.7	6.4	7.7	8.4	7.2	5.4	3.7	1.7	0.9	51.9
Twitchell Island	1.2	1.8	3.9	5.3	7.4	8.8	9.1	7.8	5.9	3.8	1.7	1.2	57.9
SAN BENITO													
Hollister	1.5	1.8	3.1	4.3	5.5	5.7	6.4	5.9	5.0	3.5	1.7	1.1	45.1
San Benito	1.2	1.6	3.1	4.6	5.6	6.4	6.9	6.5	4.8	3.7	1.7	1.2	47.2
San Juan Valley	1.4	1.8	3.4	4.5	6.0	6.7	7.1	6.4	5.0	3.5	1.8	1.4	49.1
SAN BERNARDINO													
Baker	2.7	3.9	6.1	8.3	10.4	11.8	12.2	11.0	8.9	6.1	3.3	2.1	86.6
Barstow NE	2.2	2.9	5.3	6.9	9.0	10.1	9.9	8.9	6.8	4.8	2.7	2.1	71.7
Big Bear Lake	1.8	2.6	4.6	6.0	7.0	7.6	8.1	7.4	5.4	4.1	2.4	1.8	58.6
Chino	2.1	2.9	3.9	4.5	5.7	6.5	7.3	7.1	5.9	4.2	2.6	2.0	54.6
Crestline	1.5	1.9	3.3	4.4	5.5	6.6	7.8	7.1	5.4	3.5	2.2	1.6	50.8
Lake Arrowhead	1.8	2.6	4.6	6.0	7.0	7.6	8.1	7.4	5.4	4.1	2.4	1.8	58.6
Lucerne Valley	2.2	2.9	5.1	6.5	9.1	11.0	11.4	9.9	7.4	5.0	3.0	1.8	75.3
Needles	3.2	4.2	6.6	8.9	11.0	12.4	12.8	11.0	8.9	6.6	4.0	2.7	92.1
Newberry Springs	2.1	2.9	5.3	8.4	9.8	10.9	11.1	9.9	7.6	5.2	3.1	2.0	78.2
San Bernardino	2.0	2.7	3.8	4.6	5.7	6.9	7.9	7.4	5.9	4.2	2.6	2.0	55.6

COUNTY AND CITY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL ETo
SAN BERNARDINO (cont.)													
Twentynine Palms	2.6	3.6	5.9	7.9	10.1	11.2	11.2	10.3	8.6	5.9	3.4	2.2	82.9
Victorville	2.0	2.6	4.6	6.2	7.3	8.9	9.8	9.0	6.5	4.7	2.7	2.1	66.2
SAN DIEGO													
Chula Vista	2.2	2.7	3.4	3.8	4.9	4.7	5.5	4.9	4.5	3.4	2.4	2.0	44.2
Escondido SPV	2.4	2.6	3.9	4.7	5.9	6.5	7.1	6.7	5.3	3.9	2.8	2.3	54.2
Miramar	2.3	2.5	3.7	4.1	5.1	5.4	6.1	5.8	4.5	3.3	2.4	2.1	47.1
Oceanside	2.2	2.7	3.4	3.7	4.9	4.6	4.6	5.1	4.1	3.3	2.4	2.0	42.9
Otay Lake	2.3	2.7	3.9	4.6	5.6	5.9	6.2	6.1	4.8	3.7	2.6	2.2	50.4
Pine Valley	1.5	2.4	3.8	5.1	6.0	7.0	7.8	7.3	6.0	4.0	2.2	1.7	54.8
Ramona	2.1	2.1	3.4	4.6	5.2	6.3	6.7	6.8	5.3	4.1	2.8	2.1	51.6
San Diego	2.1	2.4	3.4	4.6	5.1	5.3	5.7	5.6	4.3	3.6	2.4	2.0	46.5
Santee	2.1	2.7	3.7	4.5	5.5	6.1	6.6	6.2	5.4	3.8	2.6	2.0	51.1
Torrey Pines	2.2	2.3	3.4	3.9	4.0	4.1	4.6	4.7	3.8	2.8	2.0	2.0	39.8
Warner Springs	1.6	2.7	3.7	4.7	5.7	7.6	8.3	7.7	6.3	4.0	2.5	1.3	56.0
SAN FRANCISCO													
San Francisco	1.5	1.3	2.4	3.0	3.7	4.6	4.9	4.8	4.1	2.8	1.3	0.7	35.1
SAN JOAQUIN													
Farmington	1.5	1.5	2.9	4.7	6.2	7.6	8.1	6.8	5.3	3.3	1.4	0.7	50.0
Lodi West	1.0	1.6	3.3	4.3	6.3	6.9	7.3	6.4	4.5	3.0	1.4	0.8	46.7
Manteca	0.9	1.7	3.4	5.0	6.5	7.5	8.0	7.1	5.2	3.3	1.6	0.9	51.2
Stockton	0.8	1.5	2.9	4.7	6.2	7.4	8.1	6.8	5.3	3.2	1.4	0.6	49.1
Tracy	1.0	1.5	2.9	4.5	6.1	7.3	7.9	6.7	5.3	3.2	1.3	0.7	48.5
SAN LUIS OBISPO													
Arroyo Grande	2.0	2.2	3.2	3.8	4.3	4.7	4.3	4.6	3.8	3.2	2.4	1.7	40.0
Atascadero	1.2	1.5	2.8	3.9	4.5	6.0	6.7	6.2	5.0	3.2	1.7	1.0	43.7
Morro Bay	2.0	2.2	3.1	3.5	4.3	4.5	4.6	4.6	3.8	3.5	2.1	1.7	39.9
Nipomo	2.2	2.5	3.8	5.1	5.7	6.2	6.4	6.1	4.9	4.1	2.9	2.3	52.1
Paso Robles	1.6	2.0	3.2	4.3	5.5	6.3	7.3	6.7	5.1	3.7	2.1	1.4	49.0
San Luis Obispo	2.0	2.2	3.2	4.1	4.9	5.3	4.6	5.5	4.4	3.5	2.4	1.7	43.8
San Miguel	1.6	2.0	3.2	4.3	5.0	6.4	7.4	6.8	5.1	3.7	2.1	1.4	49.0
San Simeon	2.0	2.0	2.9	3.5	4.2	4.4	4.6	4.3	3.5	3.1	2.0	1.7	38.1
SAN MATEO													
Hal Moon Bay	1.5	1.7	2.4	3.0	3.9	4.3	4.3	4.2	3.5	2.8	1.3	1.0	33.7
Redwood City	1.5	1.8	2.9	3.8	5.2	5.3	6.2	5.6	4.8	3.1	1.7	1.0	42.8
Woodside	1.8	2.2	3.4	4.8	5.6	6.3	6.5	6.2	4.8	3.7	2.4	1.8	49.5
SANTA BARBARA													
Betteravia	2.1	2.6	4.0	5.2	6.0	5.9	5.8	5.4	4.1	3.3	2.7	2.1	49.1
Carpenteria	2.0	2.4	3.2	3.9	4.8	5.2	5.5	5.7	4.5	3.4	2.4	2.0	44.9
Cuyama	2.1	2.4	3.8	5.4	6.9	7.9	8.5	7.7	5.9	4.5	2.6	2.0	59.7

COUNTY AND CITY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL ETo
SANTA BARBARA (cont.)													
Goleta	2.1	2.5	3.9	5.1	5.7	5.7	5.4	5.4	4.2	3.2	2.8	2.2	48.1
Goleta Foothills	2.3	2.6	3.7	5.4	5.3	5.6	5.5	5.7	4.5	3.9	2.8	2.3	49.6
Guadalupe	2.0	2.2	3.2	3.7	4.9	4.6	4.5	4.6	4.1	3.3	2.4	1.7	41.1
Lompoc	2.0	2.2	3.2	3.7	4.8	4.6	4.9	4.8	3.9	3.2	2.4	1.7	41.1
Los Alamos	1.8	2.0	3.2	4.1	4.9	5.3	5.7	5.5	4.4	3.7	2.4	1.6	44.6
Santa Barbara	2.0	2.5	3.2	3.8	4.6	5.1	5.5	4.5	3.4	2.4	1.8	1.8	40.6
Santa Maria	1.8	2.3	3.7	5.1	5.7	5.8	5.6	5.3	4.2	3.5	2.4	1.9	47.4
Santa Ynez	1.7	2.2	3.5	5.0	5.8	6.2	6.4	6.0	4.5	3.6	2.2	1.7	48.7
Sisquoc	2.1	2.5	3.8	4.1	6.1	6.3	6.4	5.8	4.7	3.4	2.3	1.8	49.2
Solvang	2.0	2.0	3.3	4.3	5.0	5.6	6.1	5.6	4.4	3.7	2.2	1.6	45.6
SANTA CLARA													
Gilroy	1.3	1.8	3.1	4.1	5.3	5.6	6.1	5.5	4.7	3.4	1.7	1.1	43.6
Los Gatos	1.5	1.8	2.8	3.9	5.0	5.6	6.2	5.5	4.7	3.2	1.7	1.1	42.9
Morgan Hill	1.5	1.8	3.4	4.2	6.3	7.0	7.1	6.0	5.1	3.7	1.9	1.4	49.5
Palo Alto	1.5	1.8	2.8	3.8	5.2	5.3	6.2	5.6	5.0	3.2	1.7	1.0	43.0
San Jose	1.5	1.8	3.1	4.1	5.5	5.8	6.5	5.9	5.2	3.3	1.8	1.0	45.3
SANTA CRUZ													
De Laveaga	1.4	1.9	3.3	4.7	4.9	5.3	5.0	4.8	3.6	3.0	1.6	1.3	40.8
Green Valley Rd	1.2	1.8	3.2	4.5	4.6	5.4	5.2	5.0	3.7	3.1	1.6	1.3	40.6
Santa Cruz	1.5	1.8	2.6	3.5	4.3	4.4	4.8	4.4	3.8	2.8	1.7	1.2	36.6
Watsonville	1.5	1.8	2.7	3.7	4.6	4.5	4.9	4.2	4.0	2.9	1.8	1.2	37.7
Webb	1.8	2.2	3.7	4.8	5.3	5.7	5.6	5.3	4.3	3.4	2.4	1.8	46.2
SHASTA													
Burney	0.7	1.0	2.1	3.5	4.9	5.9	7.4	6.4	4.4	2.9	0.9	0.6	40.9
Fall River Mills	0.6	1.0	2.1	3.7	5.0	6.1	7.8	6.7	4.6	2.8	0.9	0.5	41.8
Glenburn	0.6	1.0	2.1	3.7	5.0	6.3	7.8	6.7	4.7	2.8	0.9	0.6	42.1
McArthur	0.7	1.4	2.9	4.2	5.6	6.9	8.2	7.2	5.0	3.0	1.1	0.6	46.8
Redding	1.2	1.4	2.6	4.1	5.6	7.1	8.5	7.3	5.3	3.2	1.4	0.9	48.8
SIERRA													
Downieville	0.7	1.0	2.3	3.5	5.0	6.0	7.4	6.2	4.7	2.8	0.9	0.6	41.3
Sierraville	0.7	1.1	2.2	3.2	4.5	5.9	7.3	6.4	4.3	2.6	0.9	0.5	39.6
SISKIYOU													
Happy Camp	0.5	0.9	2.0	3.0	4.3	5.2	6.1	5.3	4.1	2.4	0.9	0.5	35.1
MacDoel	1.0	1.7	3.1	4.5	5.9	7.2	8.1	7.1	5.1	3.1	1.5	1.0	49.0
Mt Shasta	0.5	0.9	2.0	3.0	4.5	5.3	6.7	5.7	4.0	2.2	0.7	0.5	36.0
Tule lake FS	0.7	1.3	2.7	4.0	5.4	6.3	7.1	6.4	4.7	2.8	1.0	0.6	42.9
Weed	0.5	0.9	2.0	2.5	4.5	5.3	6.7	5.5	3.7	2.0	0.9	0.5	34.9
Yreka	0.6	0.9	2.1	3.0	4.9	5.8	7.3	6.5	4.3	2.5	0.9	0.5	39.2

COUNTY AND CITY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL ETo
SOLANO													
Benicia	1.3	1.4	2.7	3.8	4.9	5.0	6.4	5.5	4.4	2.9	1.2	0.7	40.3
Dixon	0.7	1.4	3.2	5.2	6.3	7.6	8.2	7.2	5.5	4.3	1.6	1.1	52.1
Fairfield	1.1	1.7	2.8	4.0	5.5	6.1	7.8	6.0	4.8	3.1	1.4	0.9	45.2
Hastings Tract	1.6	2.2	3.7	5.1	6.8	7.8	8.7	7.8	5.7	4.0	2.1	1.6	57.1
Putah Creek	1.0	1.6	3.2	4.9	6.1	7.3	7.9	7.0	5.3	3.8	1.8	1.2	51.0
Rio Vista	0.9	1.7	2.8	4.4	5.9	6.7	7.9	6.5	5.1	3.2	1.3	0.7	47.0
Suisun Valley	0.6	1.3	3.0	4.7	5.8	7.0	7.7	6.8	5.3	3.8	1.4	0.9	48.3
Winters	0.9	1.7	3.3	5.0	6.4	7.5	7.9	7.0	5.2	3.5	1.6	1.0	51.0
SONOMA													
Bennett Valley	1.1	1.7	3.2	4.1	5.5	6.5	6.6	5.7	4.5	3.1	1.5	0.9	44.4
Cloverdale	1.1	1.4	2.6	3.4	5.0	5.9	6.2	5.6	4.5	2.8	1.4	0.7	40.7
Fort Ross	1.2	1.4	2.2	3.0	3.7	4.5	4.2	4.3	3.4	2.4	1.2	0.5	31.9
Healdsburg	1.2	1.5	2.4	3.5	5.0	5.9	6.1	5.6	4.5	2.8	1.4	0.7	40.8
Lincoln	1.2	1.7	2.8	4.7	6.1	7.4	8.4	7.3	5.4	3.7	1.9	1.2	51.9
Petaluma	1.2	1.5	2.8	3.7	4.6	5.6	4.6	5.7	4.5	2.9	1.4	0.9	39.6
Santa Rosa	1.2	1.7	2.8	3.7	5.0	6.0	6.1	5.9	4.5	2.9	1.5	0.7	42.0
Valley of the Moon	1.0	1.6	3.0	4.5	5.6	6.6	7.1	6.3	4.7	3.3	1.5	1.0	46.1
Windsor	0.9	1.6	3.0	4.5	5.5	6.5	6.5	5.9	4.4	3.2	1.4	1.0	44.2
STANISLAUS													
Denair	1.0	1.9	3.6	4.7	7.0	7.9	8.0	6.1	5.3	3.4	1.5	1.0	51.4
La Grange	1.2	1.5	3.1	4.7	6.2	7.7	8.5	7.3	5.3	3.4	1.4	0.7	51.2
Modesto	0.9	1.4	3.2	4.7	6.4	7.7	8.1	6.8	5.0	3.4	1.4	0.7	49.7
Newman	1.0	1.5	3.2	4.6	6.2	7.4	8.1	6.7	5.0	3.4	1.4	0.7	49.3
Oakdale	1.2	1.5	3.2	4.7	6.2	7.7	8.1	7.1	5.1	3.4	1.4	0.7	50.3
Patterson	1.3	2.1	4.2	5.4	7.9	8.6	8.2	6.6	5.8	4.0	1.9	1.3	57.3
Turlock	0.9	1.5	3.2	4.7	6.5	7.7	8.2	7.0	5.1	3.4	1.4	0.7	50.2
SUTTER													
Nicolaus	0.9	1.6	3.2	4.9	6.3	7.5	8.0	6.9	5.2	3.4	1.5	0.9	50.2
Yuba City	1.3	2.1	2.8	4.4	5.7	7.2	7.1	6.1	4.7	3.2	1.2	0.9	46.7
TEHAMA													
Corning	1.2	1.8	2.9	4.5	6.1	7.3	8.1	7.2	5.3	3.7	1.7	1.1	50.7
Gerber	1.0	1.8	3.5	5.0	6.6	7.9	8.7	7.4	5.8	4.1	1.8	1.1	54.7
Gerber Dryland	0.9	1.6	3.2	4.7	6.7	8.4	9.0	7.9	6.0	4.2	2.0	1.0	55.5
Red Bluff	1.2	1.8	2.9	4.4	5.9	7.4	8.5	7.3	5.4	3.5	1.7	1.0	51.1
TRINITY													
Hay Fork	0.5	1.1	2.3	3.5	4.9	5.9	7.0	6.0	4.5	2.8	0.9	0.7	40.1
Weaverville	0.6	1.1	2.2	3.3	4.9	5.9	7.3	6.0	4.4	2.7	0.9	0.7	40.0

COUNTY AND CITY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL ETo
TULARE													
Alpaugh	0.9	1.7	3.4	4.8	6.6	7.7	8.2	7.3	5.4	3.4	1.4	0.7	51.6
Badger	1.0	1.3	2.7	4.1	6.0	7.3	7.7	7.0	4.8	3.3	1.4	0.7	47.3
Delano	1.1	1.9	4.0	4.9	7.2	7.9	8.1	7.3	5.4	3.2	1.5	1.2	53.6
Dinuba	1.1	1.5	3.2	4.7	6.2	7.7	8.5	7.3	5.3	3.4	1.4	0.7	51.2
Lindcove	0.9	1.6	3.0	4.8	6.5	7.6	8.1	7.2	5.2	3.4	1.6	0.9	50.6
Porterville	1.2	1.8	3.4	4.7	6.6	7.7	8.5	7.3	5.3	3.4	1.4	0.7	52.1
Visalia	0.9	1.7	3.3	5.1	6.8	7.7	7.9	6.9	4.9	3.2	1.5	0.8	50.7
TUOLUMNE													
Groveland	1.1	1.5	2.8	4.1	5.7	7.2	7.9	6.6	5.1	3.3	1.4	0.7	47.5
Sonora	1.1	1.5	2.8	4.1	5.8	7.2	7.9	6.7	5.1	3.2	1.4	0.7	47.6
VENTURA													
Camarillo	2.2	2.5	3.7	4.3	5.0	5.2	5.9	5.4	4.2	3.0	2.5	2.1	46.1
Oxnard	2.2	2.5	3.2	3.7	4.4	4.6	5.4	4.8	4.0	3.3	2.4	2.0	42.3
Piru	2.8	2.8	4.1	5.6	6.0	6.8	7.6	7.8	5.8	5.2	3.7	3.2	61.5
Port Hueneme	2.0	2.3	3.3	4.6	4.9	4.9	4.9	5.0	3.7	3.2	2.5	2.2	43.5
Thousand Oaks	2.2	2.6	3.4	4.5	5.4	5.9	6.7	6.4	5.4	3.9	2.6	2.0	51.0
Ventura	2.2	2.6	3.2	3.8	4.6	4.7	5.5	4.9	4.1	3.4	2.5	2.0	43.5
YOLO													
Bryte	0.9	1.7	3.3	5.0	6.4	7.5	7.9	7.0	5.2	3.5	1.6	1.0	51.0
Davis	1.0	1.9	3.3	5.0	6.4	7.6	8.2	7.1	5.4	4.0	1.8	1.0	52.5
Esparto	1.0	1.7	3.4	5.5	6.9	8.1	8.5	7.5	5.8	4.2	2.0	1.2	55.8
Winters	1.7	1.7	2.9	4.4	5.8	7.1	7.9	6.7	5.3	3.3	1.6	1.0	49.4
Woodland	1.0	1.8	3.2	4.7	6.1	7.7	8.2	7.2	5.4	3.7	1.7	1.0	51.6
Zamora	1.1	1.9	3.5	5.2	6.4	7.4	7.8	7.0	5.5	4.0	1.9	1.2	52.8
YUBA													
Browns Valley	1.0	1.7	3.1	4.7	6.1	7.5	8.5	7.6	5.7	4.1	2.0	1.1	52.9
Brownsville	1.1	1.4	2.6	4.0	5.7	6.8	7.9	6.8	5.3	3.4	1.5	0.9	47.4

** The values in this table were derived from:*

1) California Irrigation Management Information System (CIMIS);

2) Reference EvapoTranspiration Zones Map, UC Dept. of Land, Air & Water Resources and California Dept of Water Resources 1999; and

3) Reference Evapotranspiration for California, University of California, Department of Agriculture and Natural Resources (1987) Bulletin 1922;

4) Determining Daily Reference Evapotranspiration, Cooperative Extension UC Division of Agriculture and Natural Resources (1987), Publication Leaflet 21426

WATER EFFICIENT LANDSCAPE WORKSHEET

This worksheet is filled out by the project applicant and it is a required element of the Landscape Documentation Package.

Reference Evapotranspiration (ETo) ______________

HYDROZONE # /PLANTING DESCRIPTION[a]	PLANT FACTOR (PF)	IRRIGATION METHOD[b]	IRRIGATION EFFICIENCY (IE)[c]	ETAF (PF/IE)	LANDSCAPE AREA (sq. ft.)	ETAF x AREA	ESTIMATED TOTAL WATER USE (ETWU)[e]
Regular Landscape Areas							
				Totals	**(A)**	**(B)**	
Special Landscape Areas							
				1			
				1			
				1			
				Totals	**(C)**	**(D)**	
						ETWU Total	
						Maximum Allowed Water Allowance (MAWA)[e]	

[a]Hydrozone #/Planting Description
E.g., 1.) front lawn
2.) low water use plantings
3.) medium water use planting

[b]Irrigation Method
overhead spray or drip

[c]Irrigation Efficiency
0.75 for spray head
0.81 for drip

[d]ETWU (Annual Gallons Required) = ETo x 0.62 x ETAF x Area
where 0.62 is a conversion factor that converts acre-inches per acre per year to gallons per square foot per year.

[e]MAWA (Annual Gallons Allowed) = (ETo) (0.62) [(ETAF x LA) + ((1-ETAF) x SLA)]
where 0.62 is a conversion factor that converts acre-inches per acre per year to gallons per square foot per year, LA is the total landscape area in square feet, SLA is the total special landscape area in square feet, and ETAF is .55 for residential areas and 0.45 for non-residential areas.

ETAF Calculations

Regular Landscape Areas	
Total ETAF x Area	(B)
Total Area	(A)
Average ETAF	**B ÷ A**

Average ETAF for Regular Landscape Areas must be 0.55 or below for residential areas, and 0.45 or below for non-residential areas.

All Landscape Areas	
Total ETAF x Area	(B+D)
Total Area	(A+C)
Sitewide ETAF	**(B+D) ÷ (A+C)**

CERTIFICATE OF COMPLETION

This certificate is filled out by the project applicant upon completion of the landscape project.

PART 1. PROJECT INFORMATION SHEET

Date		
Project Name		
Name of Project Applicant	Telephone No.	
	Fax No.	
Title	Email Address	
Company	Street Address	
City	State	Zip Code

Project Address and Location:

Street Address:		Parcel, tract or lot number, if available:
City		Latitude/Longitude (optional):
State	Zip Code	

Property Owner or His/Her Designee:

Name	Telephone No.	
	Fax No.	
Title	Email Address	
Company	Street Address	
City	Stat	Zip Code

Property Owner

"I/we certify that I/we have received copies of all the documents within the Landscape Documentation Package and the Certificate of Completion and that it is our responsibility to see that the project is maintained in accordance with the Landscape and Irrigation Maintenance Schedule."

____ ____________________
Property Owner Signature Date

Please answer the questions below:

1. Date the Landscape Documentation Package was submitted to the local agency ________________
2. Date the Landscape Documentation Package was approved by the local agency ________________
3. Date that a copy of the Water Efficient Landscape Worksheet (including the Water Budget Calculation) was submitted to the local water purveyor ________________

PART 2. CERTIFICATION OF INSTALLATION ACCORDING TO THE LANDSCAPE DOCUMENTATION PACKAGE

"I/we certify that based upon periodic site observations, the work has been completed in accordance with the ordinance and that the landscape planting and irrigation installation conform with the criteria and specifications of the approved Landscape Documentation Package."

Signature*	Date	
Name (print)	Telephone No.	
	Fax No.	
Title	Email Address	
License No. or Certification No.		
Company	Street Address	
City	State	Zip Code

**Signer of the landscape design plan, signer of the irrigation plan, or a licensed landscape contractor.*

PART 3. IRRIGATION SCHEDULING

Attach parameters for setting the irrigation schedule on controller per ordinance Section 492.10.

PART 4. SCHEDULE OF LANDSCAPE AND IRRIGATION MAINTENANCE

Attach schedule of Landscape and Irrigation Maintenance per ordinance Section 492.11.

PART 5. LANDSCAPE IRRIGATION AUDIT REPORT

Attach Landscape Irrigation Audit Report per ordinance Section 492.12.

PART 6. SOIL MANAGEMENT REPORT

Attach soil analysis report, if not previously submitted with the Landscape Documentation Package per ordinance Section 492.6.

Attach documentation verifying implementation of recommendations from soil analysis report per ordinance Section 492.6.

(a) This appendix contains prescriptive requirements which may be used as a compliance option to the Model Water Efficient Landscape Ordinance.

(b) Compliance with the following items is mandatory and must be documented on a landscape plan in order to use the prescriptive compliance option:

(1) Submit a Landscape Documentation Package which includes the following elements:

(A) date

(B) project applicant

(C) project address (if available, parcel and/or lot number(s))

(D) total landscape area (square feet), including a breakdown of turf and plant material

(E) project type (e.g., new, rehabilitated, public, private, cemetery, homeowner-installed)

(F) water supply type (e.g., potable, recycled, well) and identify the local retail water purveyor if the applicant is not served by a private well

(G) contact information for the project applicant and property owner

(H) applicant signature and date with statement, "I agree to comply with the requirements of the prescriptive compliance option to the MWELO".

(2) Incorporate compost at a rate of at least four cubic yards per 1,000 square feet to a depth of six inches into landscape area (unless contra-indicated by a soil test);

(3) Plant material shall comply with all of the following;

(A) For residential areas, install climate adapted plants that require occasional, little or no summer water (average WUCOLS plant factor 0.3) for 75% of the plant area excluding edibles and areas using recycled water; For non-residential areas, install climate adapted plants that require occasional, little or no summer water (average WUCOLS plant factor 0.3) for 100% of the plant area excluding edibles and areas using recycled water;

(B) A minimum three inch (3") layer of mulch shall be applied on all exposed soil surfaces of planting areas except in turf areas, creeping or rooting groundcovers, or direct seeding applications where mulch is contraindicated.

(4) Turf shall comply with all of the following:

(A) Turf shall not exceed 25% of the landscape area in residential areas, and there shall be no turf in non-residential areas;

(B) Turf shall not be planted on sloped areas which exceed a slope of 1 foot vertical elevation change for every 4 feet of horizontal length;

(C) Turf is prohibited in parkways less than 10 feet wide, unless the parkway is adjacent to a parking strip and used to enter and exit vehicles. Any turf in parkways must be irrigated by sub-surface irrigation or by other technology that creates no overspray or runoff.

(5) Irrigation systems shall comply with the following:

(A) Automatic irrigation controllers are required and must use evapotranspiration or soil moisture sensor data and utilize a rain sensor.

(B) Irrigation controllers shall be of a type which does not lose programming data in the event the primary power source is interrupted.

(C) Pressure regulators shall be installed on the irrigation system to ensure the dynamic pressure of the system is within the manufacturers recommended pressure range.

(D) Manual shut-off valves (such as a gate valve, ball valve, or butterfly valve) shall be installed as close as possible to the point of connection of the water supply.

(E) All irrigation emission devices must meet the requirements set in the ANSI standard, ASABE/ICC 802-2014, "Landscape Irrigation Sprinkler and Emitter Standard". All sprinkler heads installed in the landscape must document a distribution uniformity low quarter of 0.65 or higher using the protocol defined in ASABE/ICC 802-2014.

(F) Areas less than ten (10) feet in width in any direction shall be irrigated with subsurface irrigation or other means that produces no runoff or overspray.

(6) For non-residential projects with landscape areas of 1,000 sq. ft. or more, a private submeter(s) to measure landscape water use shall be installed.

(c) At the time of final inspection, the permit applicant must provide the owner of the property with a certificate of completion, certificate of installation, irrigation schedule and a schedule of landscape and irrigation maintenance.

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APPENDIXF
PROPOSED CONSTRUCTION BUILDING CODES FOR
TURF ANDLANDSCAPE IRRIGATION SYSTEMS

PART 1: GENERAL

A. **Description.**

1. **Purpose.** To establish uniform minimum standards and requirements for the design and installation of safe, cost effective, reliable irrigation systems for turf and landscape areas which promote the efficient use and protection of water and other natural resources.

2. **Definition.** Turf and landscape irrigation systems apply water by means of permanent above-ground or subsurface sprinkler or microsprinkler equipment under pressure.

3. **Scope.** These construction codes shall apply to all irrigation systems used on residential and commercial landscape areas. They address the design requirements, water quality, materials, installation, inspection, and testing for such systems. These construction codes do not apply to irrigation systems for golf courses, nurseries, greenhouses, or agricultural production systems.

4. **Application.** All new irrigation systems and any new work to existing irrigation systems shall conform to the requirements of this code.

5. **Application to existing irrigation installations.** Nothing contained in this code shall be deemed to require any irrigation system or part thereof, which existed prior to the establishment of this code, to be changed, altered or modified to meet the standards of this code.

B. **Permits.**

1. **Permits required.** It shall be unlawful to construct, enlarge, alter, modify, repair, or move any irrigation system or part thereof, or to install or alter any equipment for which provision is made or the installation of which is regulated by this code without first having filed application and obtained a permit therefore from the building official. A permit shall be deemed issued when signed by the building official and impressed with the seal of the governmental agency issuing said permit.

2. **Exceptions.** All work where exempt from permit shall still be required to comply with the code. No permit shall be required for general maintenance or repairs which do not change the structure or alter the system and the value of which does not exceed $600.00 in labor and material based on invoice value.

C. **Preconstruction submittals.**

1. **Plans or drawings.**

1. **Single-family residence.** Provide design drawings or shop drawings, where required, for the installation prior to start of construction. Design drawings shall be clearly readable, to reasonable scale, show the entire site to be irrigated, and include all improvements. Drawings can be prepared by a properly licensed qualified contractor.

2. **Commercial, industrial, municipal and multiple-family.** Provide professionally designed drawings prior to start of construction. Design drawings shall be clearly readable, to reasonable scale, show the entire site to be irrigated, including all improvements, and shall include but not be limited to: date, scale, revisions, legend, specifications which list all aspects of equipment and assembly there of, water source, water meter and/or point of connection, backflow prevention devices, pump station size, pump station location, design operating pressure and flow rate per zone, precipitation rate per zone, locations of pipe, controllers, valves, sprinklers, sleeves, gate valves, etc. The plans and specifications shall be prepared in accordance with Section 107 of the Florida Building Code, Building.

D. **Definitions.**

ABS Pipe. Acrylonitrile-butadiene-styrene black, semi-rigid, plastic pipe extruded to IPS. ABS pipe is in limited use in present day irrigation systems. Solvent weld fittings are used with this pipe (see ASTM D1788).

Air Release Valve. A valve which will automatically release to the atmosphere accumulated small pockets of air from a pressurized pipeline. A small orifice is used to release air at low flow rates. Air release valves are normally required at all summits of mainline and submain pipelines in an irrigation system.

Anti-Siphon Device. A safety device used to prevent back-flow of irrigation water to the water source by back-siphonage.

Application Rate. The average rate at which water is applied by an irrigation system, sometimes also called precipitation rate. Units are typically inches/hr or mm/hr.

Application Uniformity. Irrigation application uniformity (also known as distribution uniformity) describes how evenly water is distributed within an irrigation zone.

Arc. The angle of coverage of a sprinkler in degrees from one side of throw to the other. A 90-degree arc would be a quarter-circle sprinkler.

Atmospheric Vacuum Breaker. An anti-siphon device which uses a floating seat to direct water flow. Water draining back from irrigation lines is directed to the atmosphere to protect the potable water supply.

Automatic Control Valve. A valve in a sprinkler system which is activated by an automatic controller by way of hydraulic or electrical control lines and controls a single device or multiple devices.

Automatic System. An irrigation system which operates following a preset program entered into an automatic controller.

Backflow Prevention Device. An approved safety device used to prevent pollution or contamination of the irrigation water supply due to backflow from the irrigation system.

Belled (Pipe). Pipe which is enlarged at one end so that the spigot end of another length of pipe can be inserted into it during the assembly of a pipeline.

Block (of sprinklers). A group of sprinklers controlled by one valve. Also called zones or subunits.

Block System. An irrigation system in which several groups of sprinklers are controlled by one valve for each group.

Bubbler Irrigation. The application of water to the soil surface or a container as a small stream or fountain. Bubbler emitter discharge rates are greater than the 0.5 to 2 gph characteristic of drip emitters, but generally less than 60 gph.

Check Valve. A valve which permits water to flow in one direction only.

Chemical Water Treatment. The addition of chemicals to water to make it acceptable for use in irrigation systems

Chemigation. The application of water soluble chemicals by mixing or injecting with the water applied through an irrigation system.

Contractor. Any person who engages in the fabrication and installation of any type of irrigation system on a contractual basis in accordance with all stipulations receiving his compensation.

Control Lines. Hydraulic or electrical lines which carry signals (to open and close the valves) from the controller to the automatic valves.

Controller. The timing mechanism and its mounting box. The controller signals the automatic valves to open and close on a pre-set program or based on sensor readings.

Coverage. Refers to the way water is applied to an area.

Cycle. Refers to one complete run of a controller through all programmed controller stations.

Demand (or irrigation demand). Refers to the irrigation requirements of the irrigated area. Demand primarily depends on the type of crop, stage of growth, and climatic factors.

Design Area. The specific land area to which water is to be applied by an irrigation system.

Design Emission Uniformity. An estimate of the uniformity of water application with an irrigation system.

Design Pressure. The pressure at which the irrigation system or certain components are designed to operate. The irrigation system design pressure is that measured at the pump discharge or entrance to the system if there is no pump, and a zone design pressure is the average operating pressure of all emitters within that zone.

Direct Burial Wire. Plastic-coated single-strand copper wire for use as control line for electric valves.

Discharge Rate. The instantaneous flow rate of an individual sprinkler, emitter, or other water emitting device, or a unit length of line-source microirrigation tubing. Also, the flow rate from a pumping system.

Double Check Valve. An approved assembly of two single, independently-acting check valves with test ports to permit independent testing of each check valve.

Drain Valve. A valve used to drain water from a line. The valve may be manually or automatically operated.

Drip Irrigation. The precise low-rate application of water to or beneath the soil surface near or directly into the plant root zone. Applications normally occur as small streams, discrete or continuous drops, in the range of 0.5 to 2.0 gph.

Effluent water. Also referred to as reclaimed or gray water is wastewater which has been treated per Florida Statute, §403.086 and is suitable for use as a water supply for irrigation systems.

Emitters. Devices which are used to control the discharge of irrigation water from lateral pipes. This term is primarily used to refer to the low flow rate devices used in microirrigation systems.

Fertigation. The application of soluble fertilizers with the water applied through an irrigation system.

Filtration System. The assembly of physical components used to remove suspended solids from irrigation water. These include both pressure and gravity type devices, such as settling basins, screens, media filters, and centrifugal force units (vortex sand separators).

Flexible Swing Joint. A flexible connection between the lateral pipe and the sprinkler which allows the sprinkler to move when force is applied to it.

Flow Meters. Devices used to measure the volume of flow of water (typically in gallons), or flow rates (typically in gpm), and to provide data on system usage.

Gauge (Wire). Standard specification for wire size. The larger the gauge number, the smaller the wire diameter.

Head. A sprinkler head. Sometimes used interchangeably with and in conjunction with “Sprinkler.”

Infiltration Rate. The rate of water flow across the surface of the soil and into the soil profile. Units are usually inches/hr.

Irrigation. Application of water by artificial means, that is, means other than natural precipitation. Irrigation is practiced to supply crop water requirements, leach salts, apply chemicals, and for environmental control including crop cooling and freeze protection.

Irrigation Water Requirement or Irrigation Requirement. The quantity of water that is required for crop production, exclusive of effective rainfall.

Landscape. Refers to any and all areas which are ornamentally planted, including but not limited to turf, ground covers, flowers, shrubs, trees, and similar plant materials as opposed to agricultural crops grown and harvested for monetary return.

Lateral. The water delivery pipeline that supplies water to the emitters or sprinklers from a manifold or header pipeline downstream of the control valve.

Line-Source Emitters. Lateral pipelines which are porous or contain closely-spaced perforations so that water is discharged as a continuous band or in overlapping patterns rather than discrete widely-spaced points along the pipeline length.

Looped System. A piping system which allows more than one path for water to flow from the supply to the emitters or sprinklers.

Low Volume Sprinklers. Sprinkler heads that emit less than 0.5 gallons per minute.

Mainline. A pipeline which carries water from the control station to submains or to manifolds or header pipelines of the water distribution system.

Manifold. The water delivery pipeline that conveys water from the main or submain pipelines to the laterals. Also sometimes called a header pipeline.

Manual System. A system in which control valves are manually operated rather than operated by automatic controls.

Matched Precipitation. An equal distribution of water over a given area or zone.

Meter Box. A concrete or plastic box buried flush to grade which houses flow (water) meters or other components.

Microirrigation. The frequent application of small quantities of water directly on or below the soil surface, usually as discrete drops, tiny streams, or miniature sprays through emitters placed along the water delivery pipes (laterals). Microirrigation encompasses a number of methods or concepts, including drip, subsurface, bubbler, and spray irrigation. Previously known as trickle irrigation.

Overlap. The amount one sprinkler pattern overlaps another one when installed in a pattern. Expressed as a percentage of the diameter of coverage.

PE Pipe. Flexible polyethylene pipe for use in irrigation systems, normally manufactured with carbon black for resistance to degradation by ultraviolet radiation.

Potable Water. Water which is suitable in quality for human consumption and meets the requirements of the Health Authority having jurisdiction.

Pressure Relief Valve. A valve which will open and discharge to atmosphere when the pressure in a pipeline or pressure vessel exceeds a pre-set point to relieve the high-pressure condition.

Pressure Vacuum Breaker. A backflow prevention device which includes a spring-loaded check valve and a spring-loaded vacuum breaker to prevent the backflow of irrigation system water to the water source.

Pumping Station. The pump or pumps that provide water to an irrigation system, together with all of the necessary accessories such as bases or foundations, sumps, screens, valves, motor controls, safety devices, shelters and fences.

PVC Pipe. Polyvinyl chloride plastic pipe made in standard thermoplastic pipe dimension ratios and pressure rated for water. Manufactured in accordance with AWWA C-900 or ASTM D2241.

Rain Shut off Device. A calibrated device that is designed to detect rainfall and override the irrigation cycle of the sprinkler system when a predetermined amount of rain fall has occurred.

Riser. A threaded pipe to which sprinklers or other emitters are attached for above-ground placement.

Sleeve. A pipe used to enclose other pipes, wire, or tubing; usually under pavement, sidewalks, or planters.

Spacing. The distance between sprinklers or other emitters.

Spray Irrigation. The microirrigation application of water to the soil or plant surface by low flow rate sprays or mists.

Sprinkler. The sprinkler head. Sometimes called “Head.”

Supply (Water Source). The origin of the water used in the irrigation system.

Swing Joint. A ridged connection between the lateral pipe and the sprinkler, utilizing multiple ells and nipples, which allows the sprinkler to move when force is applied to it.

Tubing. Generally used to refer to flexible plastic hydraulic control lines which are usually constructed of PE or PVC.

PART II — DESIGN CRITERIA

A. **Design defined.** Within the scope of this code, irrigation system design is defined as the science and art of properly selecting and applying all components within the system. The irrigation system shall be designed and installed to achieve the highest possible efficiency by providing operating pressures, sprinkler placement and nozzle selection that are within the manufacturer's recommendations, and maintained to keep the system at or within those ranges.

B. **Water supply.**

1. The water source shall be adequate from the stand point of volume, flow rate, pressure, and quality to meet the irrigation requirements of the area to be irrigated, as well as other demands, if any, both at the time the system is designed and for the expected life of the system. The irrigation system shall use the lowest quality water source available on site.

2. If the water source is effluent, it shall meet the advanced waste treatment standard as set forth in Florida Statute §403.086(4) as well as any other standard as set forth by the controlling governmental agency.

C. **Application uniformity.**

1. Sprinkler irrigation systems should be designed with the appropriate uniformity for the type of plants being grown and the type of soil found in that area. The general watering of different types of plants as one group without regard to their individual water requirements is to be avoided.

2. Use sprinkler head spacing, type and nozzle selection to achieve the highest application uniformity.

3. Use application rates which avoid runoff and permit uniform water infiltration into the soil. Land slope, soil hydraulic properties, vegetative ground cover, and prevailing winds and sun exposure will be considered when application rates are specified. Different types of sprinklers with different application rates, i.e., spray heads vs. rotor heads, bubbler heads vs. rotor heads, shall not be combined on the same zone or circuit.

D. **System zoning.** The irrigation system should be divided into zones based on consideration of the following hydrozoning practices.

1. Available flow rate.

2. Cultural use of the area.

3. Type of vegetation irrigated, i.e., turf, shrubs, native plants, etc.

4. Type of sprinkler, i.e., sprinklers with matching precipitation rates.

5. Soil characteristics and slope.

6. Sun exposure.

E. **Sprinkler/emitter spacing and selection.**

1. Sprinkler/Emitter spacing will be determined considering the irrigation requirements, hydraulic characteristics of the soil and device, and water quality with its effect on plant growth, sidewalks, buildings, and public access areas.

2. All pop-up spray head bodies in turf areas shall be no less than 6 inches in height for St. Augustine, Zoysia and Bahia and no less than 4 inches in height for Bermuda, Centapede and Seashore Paspalum.

3. Sprinklers should be located in all corners and on the perimeter of each irrigated zone area for a matched precipitation rate objective.

4. Single row head spacing should only occur when an additional row will cause saturated soils at the toe of a slope or other inefficiencies.

5. All heads shall not exceed 50 percent of manufacturer's specified diameters of coverage.

6. Water conservation will be emphasized by minimizing irrigation of nonvegetated areas.

7. Microirrigation systems should be designed using the Emission Uniformity concept. Space microirrigation emitters to wet 100 percent of the root zone in turf areas and 50 percent of the root zone for shrubs and trees.

8. Microirrigation or low volume heads shall be required in all areas less than 4 feet in either direction.

9. All microirrigation zones shall have adequate filtration installed at the zone valve or at the point where the drip tubing is attached to PVC pipe to protect the emission devices from contamination from a PD main or lateral break.

10. Each plant shall have an adequate number and size (gph) of microirrigation devices, properly placed, to meet the plant water requirements for no rainfall.

F. **Pipelines.** Pipelines will be sized to limit pressure variations so that the working pressure at all points in the irrigation system will be in the range required for uniform water application. Velocities will be kept to 5 feet (1524 mm) per second.

G. **Wells.**

1. Well diameters and depths are to be sized to correspond to the irrigation system demand. Refer to SCS Code FL-642 and local water management district regulations.

2. Well location and depth shall be in compliance with applicable state, water management district and local codes.

H. **Pumps.**

1. Pump and motor combinations shall be capable of satisfying the total system demand without invading the service factor of the motor except during start-up and between zones.
2. Pumps shall be positioned with respect to the water surface in order to ensure that the net positive suction head required (NPSHr) for proper pump operation is achieved.
3. The pumping system shall be protected against the effects of the interruption of water flow.

I. **Control valves.**

1. Control valve size shall be based on the flow rate through the valve. Friction loss through the valve, an approved air gap separation, or a reduced pressure should not exceed 10 percent of the static mainline head.
2. Control systems using hydraulic communication between controller and valve(s) shall comply with the manufacturer’s recommendations for maximum distance between controller and valve, both horizontally and vertically (elevation change).
3. The size of the electrical control wire shall be in accordance with the valve manufacturer’s specifications; based on the solenoid in-rush amperage and the circuit length, considering the number of solenoids operating on the circuit. Minimum of #14 AWG single strand control wire shall be used on all systems, except individual, single lot residential systems.
4. Locate manually operated control valves so that they can be operated without wetting the operator.
5. Locate inground valves away from large tree and palm root zones.
6. A manual shut-off valve shall be required to be installed close to the point of connection but downstream from any backflow device to minimize water loss when the system is shut off for repairs or emergencies.
7. An automatic shut-off valve (normally closed) is required on all systems with a constantly pressurized mainline to confine the water loss from minor main line leaks, weeping valves, or stuck on valves to just the time the system is operating automatically.

J. **Automatic irrigation controller.** Automatic irrigation controllers must be UL approved and have an adequate number of stations and power output per station to accommodate the irrigation system design. The controller shall be capable of incorporating a rain shut-off device or other sensors to override the irrigation cycle when adequate rainfall has occurred as required by Florida Statutes, Section 373.62.

K. **Chemical injection.**

1. Chemical injection systems for the injection of fertilizer, pesticides, rust inhibitors, or any other injected substance will be located and sized according to the manufacturers' recommendations.

2. Injection systems will be located downstream of the applicable backflow prevention devices as required by Florida Statutes, Sections 487.021 and 487.055; the Environmental Protection Agency (EPA); Pesticide Regulation Notice 87-1; or other applicable codes.

3. If an irrigation water supply is also used for human consumption, an air gap separation or an approved reduced pressure principal backflow prevention device is required.

L. **Backflow prevention methods.** Provide backflow prevention assemblies at all cross connections with all water supplies in accordance with county, municipal or other applicable codes to determine acceptable backflow prevention assembly types and installation procedures for a given application. In the event of conflicting regulation provide the assembly type which gives the highest degree of protection.

1. Irrigation systems into which chemicals are injected shall conform to Florida state law (Florida Statutes 487.021 and 487.055) and Environmental Protection Agency Pesticide Regulation Notice 87-1, which requires backflow prevention regulations to be printed on the chemical label.

2. For municipal water supplies, chemical injection equipment must be separated from the water supply by an approved air gap separation or a reduced pressure principle assembly that is approved by the Foundation for CCC and the Hydraulic Research Institute. The equipment must also comply with ASSE 1013 to protect the water supply from back-siphonage and back-pressure.

3. For other water supplies, Florida State law, EPA regulations, or other applicable local codes must be followed. In the absence of legal guidelines at least a PVB should be used.

PART III — STANDARDS

1. **American Society of Agricultural Engineers (ASAE) Standards:**

    - **ASAE S330.1:** Procedure for sprinkler distribution testing for research purposes.

    - **ASAE S376.1:** Design, installation, and performance of underground thermoplastic irrigation pipelines.

- **ASAE S397.1:** Electrical service and equipment for irrigation.
- **ASAE S435:** Drip/Trickle Polyethylene Pipe used for irrigation laterals.
- **ASAE S398.1:** Procedure for sprinkler testing and performance reporting.
- **ASAE S339:** Uniform classification for water hardness.
- **ASAE S394:** Specifications for irrigation hose and couplings used with self-propelled, hose-drag agricultural irrigation system.
- **ASAE EP400.1:** Designing and constructing irrigation wells.
- **ASAE EP405:** Design, installation, and performance of trickle irrigation systems.
- **ASAE EP409:** Safety devices for applying liquid chemicals through irrigation systems.

2. **ASTM International Standards:**
    - **ASTM D2241:** Poly (Vinyl Chloride) (PVC) Plastic pipe (SDR-PR).
    - **ASTM D2239:** Specification for polyethylene (PE) plastic pipe (SDR-PR).
    - **ASTM D2466:** Specification for socket-type poly (vinyl chloride) (PVC) and chlorinated poly (vinyl chloride) (CPVC) plastic pipe fittings, Schedule 40.
    - **ASTM D2855:** Standard recommended practice for making solvent cemented joints with polyvinyl chloride pipe and fittings.
    - **ASTM D3139:** Specification for joints for plastic pressure pipes using flexible elastomeric seals.
    - **ASTM F477:** Specification for elastomeric seals (gaskets for joining plastic pipe).
3. **American Water Works Association (AWWA) standards:**
    - **AWWA C-900:** PVC pipe standards and specifications
4. **American Society of Sanitary Engineers (ASSE) Standards:**
    - **ASSE 1001:** Pipe applied atmospheric type vacuum breakers.
    - **ASSE 1013:** Reduced pressure principle backflow preventers.
    - **ASSE 1015:** Double check valve-type back pressure backflow preventers.
    - **ASSE 1020:** Vacuum breakers, anti-siphon, pressure type.
    - **ASSE 1024:** Dual check valve-type backflow preventers.

5. **Hydraulic Institute Standards, 14th Edition.**

6. **Standards and Specifications For Turf and Landscape Irrigation Systems Florida Irrigation Society (FIS) Standards.**

7. **Soil Conservation Service (SCS) Field Office Technical Guide, Section IV-A — Cropland Codes:**

    - **SCS Code 430-DD:** Irrigation water conveyance, underground, plastic pipeline.
    - **SCS Code 430-EE:** Irrigation water conveyance. Low pressure, underground, plastic pipeline.
    - **SCS Code 430-FF:** Irrigation water conveyance, steel pipeline.
    - **SOS Code 441-1:** Irrigation system, trickle.
    - **SCS Code 442:** Irrigation system sprinkler.
    - **SCS Code 449:** Irrigation water management.
    - **SCS Code 533:** Pumping plant for water control.
    - **SCS Code 642:** Well.

PART IV: MATERIALS

A. **PVC pipe and fittings.**

1. PVC pipe should comply with one of the following standards: ASTM D1785, ASTM D2241, AWWA C-900, or AWWA C-905. SDR-PR pipe shall have a minimum wall thickness as required by SDR-26. All pipe used with effluent water systems shall be designated for nonpotable use by either label or by the industry standard color purple.

2. All solvent-weld PVC fittings shall, at a minimum, meet the requirements of Schedule 40 as set forth in ASTM D2466.

3. Threaded PVC pipe firings shall meet the requirements of Schedule 40 as set forth in ASTM D2464.

4. PVC gasketed fittings shall conform to ASTM D3139. Gaskets shall conform to ASTM F477.

5. PVC flexible pipe should be pressure rated as described in ASTM D2740 with standard outside diameters compatible with PVC IPS solvent-weld fittings.

6. PVC cement should meet ASTM D2564. PVC cleaner-type should meet ASTM F656.

B. **Ductile iron pipe and fittings.**

1. Gasket fittings for iron pipe should be of materials and type compatible with the piping material being used.

C. **Steel pipe and fittings.**

1. All steel pipe shall be rated Schedule 40 or greater and be hot-dipped galvanized or black in accordance with ASTM A53/A53M.
2. Threaded fittings for steel pipe should be Schedule 40 Malleable Iron.

D. **Polyethylene pipe.**

1. Flexible swing joints shall be thick-walled with a minimum pressure rating of 75 psi (517 kPa) in accordance with ASTM D2239.
2. Low pressure polyethylene pipe for microirrigation systems shall conform with ASAE S-435.
3. Use fittings manufactured specifically for the type and dimensions of polyethylene pipe used.

E. **Sprinklers, spray heads, and emitters.**

1. Select units and nozzles in accordance with the size of the area and the type of plant material being irrigated. Sprinklers must fit the area they are intended to water without excessive overspray onto anything but the lot individual landscaped surface. Intentional direct spray onto walkways, buildings, roadways, and drives is prohibited. All sprinklers used with effluent water systems shall be designated for non-potable use by either label or by the industry standard color purple.
2. Use equipment that is protected from contamination and damage by use of seals, screens, and springs where site conditions present a potential for damage.
3. Support riser-mounted sprinklers to minimize movement of the riser resulting from the action of the sprinkler.
4. Swing joints, either flexible or rigid, shall be constructed to provide a leak-free connection between the sprinkler and lateral pipeline to allow movement in any direction and to prevent equipment damage.
5. Check valves shall be installed on any sprinkler where low point drainage occurs.
6. All tubing shall be installed under ground cover using staples at close enough intervals (24 to 36 inches) to secure the tubing and prevent it from moving through the mulch bed.

F. **Valves.**

1. Valves must have a maximum working pressure rating equal to or greater than the maximum pressure of the system, but not less than 125 psi (861 kPa). This requirement may be waived for low mainline pressure systems [30 psi (207 kPa) or less]. All valves used with effluent water systems shall be designated for nonpotable use by either label or by the industry standard color purple.

2. Only valves that are constructed of materials designed for use with the water and soil conditions of the installation shall be used. Valves that are constructed from materials that will not be deteriorated by chemicals injected into the system shall be used on all chemical injection systems.

G. **Valve boxes.**

1. Valve boxes are to be constructed to withstand traffic loads common to the area in which they are installed. They should be sized to allow manual operation of the enclosed valves without excavation.

2. Each valve box should be permanently labeled to identify its contents. All valve boxes used with effluent water systems shall be designated for nonpotable use by either label or by the industry standard color purple.

H. **Low voltage wiring.**

1. All low voltage wire which is directly buried must be labeled for direct burial wire. Wire not labeled for direct burial must be installed in watertight conduits, and be UL listed TWN or THHN type wire as described in the NEC. All wire traveling under any hardscape or roadway must installed within a pipe and sleeve.

2. The size of the electrical control wire shall be in accordance with the valve manufacturer's specifications, based on the solenoid in-rush amperage and the circuit length, considering the number of solenoids operating, on the circuit. Minimum of #14 AWG single strand control wire shall be used on all systems, except single lot individual residential systems.

3. Connections are to be made using UL approved devices specifically designed for direct burial. All splices shall be enclosed within a valve box.

I. **Irrigation controllers.**

1. All irrigation controllers shall be UL listed, conform to the provisions of the *National Electric Code* (NEC), and be properly grounded in accordance with manufacturer's recommendations. Equip solid state controls with surge suppressors on the primary and secondary wiring, except single lot residential systems.

2. The controller housing or enclosure shall protect the controller from the hazards of the environment in which it is installed.

3. The rain switch shall be placed on a stationary structure minimum of 5-foot (1524 mm) clearance from other outdoor equipment, free and clear of any tree canopy or other overhead obstructions, and above the height of the sprinkler coverage. Soil moisture sensors and ET sensors shall be installed and monitored per manufacturer's guidelines per Florida Statutes, Section 373.62 requirements.

J. **Pumps and wells.**

1. Irrigation pump electrical control systems must conform to NEC and local building codes.

2. The pumping system shall be protected from the hazards of the environment in which it is installed.

3. Use electric motors with a nominal horsepower rating greater than the maximum horsepower requirement of the pump during normal operation. Motor shall have a service factor of at least 1.15.

4. Casings for drilled wells may be steel, reinforced plastic mortar, plastic, or fiberglass pipe. Only steel pipe casings shall be used in driven wells. Steel pipe must have a wall thickness equal to or greater than Schedule 40. See SCS code FL-642. Steel casings shall be equal to or exceed requirements of ASTM A589.

K. **Chemical injection equipment.**

1. Chemical injection equipment must be constructed of materials capable of withstanding the potential corrosive effects of the chemicals being used. Equipment shall be used only for those chemicals for which it was intended as stated by the injection equipment manufacturer.

L. **Filters and strainers.**

1. Filtration equipment and strainers constructed of materials resistant to the potential corrosive and erosive effects of the water shall be used. They shall be sized to prevent the passage of foreign material that would obstruct the sprinkler/emitter outlets in accordance with the manufacturer's recommendations.

PART V: INSTALLATION

A. **Pipe installation.**

1. Pipe shall be installed at sufficient depth below ground to protect it from hazards such as vehicular traffic or routine occurrences which occur in the normal use and

maintenance of a property. Depths of cover shall meet or exceed SCS Code 430-DD, Water Conveyance, as follows:

A. Vehicle traffic areas.

Pipe Size (inches)	Depth of Cover (inches)
$^{1}/_{2}$ – $2^{1}/_{2}$	18
3 – 5	24
6 and larger	30

B. All areas except vehicle traffic:

Pipe Size (inches)	Depth of Cover (inches)
$^{1}/_{2}$ – 1 $^{1}/_{2}$	6
2 – 3	12
4 – 6	18
more than 6	24

2. Make all pipe joints and connections according to manufacturer's recommendations. Perform all solvent-weld connections in accordance with ASTM D2855.

3. Minimum clearances shall be maintained between irrigation lines and other utilities. In no case shall one irrigation pipe rest upon another. Comingling or mixing of different types of pipe assemblies shall be prohibited.

4. Thrust blocks must be used on all gasketed PVC systems. They must be formed against a solid, hand-excavated trench wall undamaged by mechanical equipment. They shall be constructed of concrete, and the space between the pipe and trench shall be filled to the height of the outside diameter of the pipe. Size thrust blocks in accordance with ASAE S-376.1.

5. The trench bottom must be uniform, free of debris, and of sufficient width to properly place pipe and support it over its entire length. Native excavated material may be used to backfill the pipe trench. However, the initial backfill material shall be free from rocks or stones larger than 1-inch in diameter. At the time of placement, the moisture content of the material shall be such that the required degree of compaction can be obtained

with the backfill method to be used. Blocking or mounding shall not be used to bring the pipe to final grade.

6. Pipe sleeves must be used to protect pipes or wires installed under pavement or roadways. Use pipe sleeves two pipe sizes larger than the carrier pipe or twice the diameter of the wire bundle to be placed under the paving or roadway and extending a minimum of 3 feet beyond the paved area or as required by the Florida Department of Transportation (FDOT). Use sleeve pipe with wall thickness at least equal to the thickness of Schedule 40 or PR 160 pipe, whichever is thicker. Proper backfill and compaction procedures should be followed.

B. **Control valve installation.**

1. Valve installation shall allow enough clearance for proper operation and maintenance. Where valves are installed underground, they shall be provided with a valve box with cover extending from grade to the body of the valve. The top of the valve body should have a minimum of 6 inches (152 mm) of cover in nontraffic and noncultivated areas and 18 inches (457 mm) of cover in traffic areas. The valve box shall be installed so as to minimize the effect of soil intrusion within the valve box with the use of filter fabric, pea gravel, or other acceptable material. If an automatic valve is installed under each sprinkler, then the valve box may be omitted.

2. Install valve boxes so that they do not rest on the pipe, the box cover does not conflict with the valve stem or interfere with valve operation, they are flush with the ground surface and do not present a tripping hazard or interfere with routine maintenance of the landscape.

3. Install quick coupling valves on swing joints or flexible pipe with the top of the valve at ground level.

4. Any above-ground manually-operated valves on nonpotable water systems will be adequately identified with distinctive purple colored paint. Do not provide hose connections on irrigation systems that utilize nonpotable water supplies.

C. **Sprinkler installation.**

1. On flat landscaped areas, install sprinklers plumb. In areas where they are installed on slopes, sprinklers may be tilted as required to prevent erosion.

2. Sprinklers should be adjusted to avoid unnecessary discharge on pavements and structures.

    A. Adjust sprinklers so they do not water on roads.

B. Provide a minimum separation of 4 inches (102 mm) between sprinklers and pavement.

C. Provide a minimum separation of 12 inches (305 mm) between sprinklers and buildings and other vertical structures.

D. Polyethylene (PE) nipples shall not be used in maintenance equipment traffic areas or alongside roadways and driveways.

3. Piping must be thoroughly flushed before installation of sprinkler nozzles.

4. Surface mounted and pop-up heads shall be installed on swing joints or flexible pipe.

5. Above-ground (riser mounted) sprinklers shall be mounted on Schedule 40 PVC or steel pipe and be effectively stabilized.

6. The pop-up height for sprays and rotator nozzles shall be adequate to prevent being obstructed by the turf grass blades: 6-inch height for St. Augustine, Zoysia and Bahia, 4-inch height for Bermuda, Centapede and Seashore Paspalum.

7. All microirrigation zones shall have adequate filtration installed at the zone valve or at the point where the drip tubing is attached to PVC pipe to protect the emission devices from contamination from a PVC main or lateral break.

8. All microirrigation zones shall have adequate pressure regulation installed at the zone valve or at the point where the drip tubing is attached to the PVC to ensure that all emission devices meet the manufacturer's performance standards.

9. Each plant shall have a adequate number and size(gph) of microirrigation devices, properly placed to meet the plant water requirements for no rainfall.

10. .All tubing shall be installed under ground cover using staples at close enough intervals (24 to 36 inches) to secure the tubing and prevent it from moving through the mulch bed.

D. **Pump installation.**

1. Install pumps as per the manufacturer's recommendations. Set pumps plumb and secure to a firm concrete base. There should be no strain or distortion on the pipe and fittings. Pipe and fittings should be supported to avoid placing undue strain on the pump. Steel pipe should be used on pumps 5 horsepower (hp) or larger whenever practical.

2. Pumps must be installed in a manner to avoid loss of prime. Install suction line to prevent the accumulation of air pockets. All connections and reductions in suction pipe sizes should be designed to avoid causing air pockets and cavitation.

3. Pumps must be located to facilitate service and ease of removal. Appropriate fittings should be provided to allow the pump to readily be primed, serviced, and disconnected. Provide an enclosure of adequate size and strength, with proper ventilation, to protect the pump from the elements (except residential systems).

E. **Low voltage wire installation.**

1. Install low voltage wire (less than 98 volts) with a minimum depth of cover of 12 inches (305 mm) where not installed directly under the mainline.

2. Provide a sufficient length of wire at each connection to allow for thermal expansion/shrinkage.

3. As a minimum, provide a 12-inch (305 mm) diameter loop at all splices and connections.

4. Terminations at valves will have 24-inches (610 mm) minimum free wire.

5. Install all above-ground wire runs and wire entries into buildings in electrical conduit.

Exception: No conduit is required when wiring above ground manifolds from the valve to the ground immediately beneath it.

6. Provide common wires with a different color than the power wires (white shall be used for common wires).

7. Connections are to be made using UL approved devices specifically designed for direct burial.

8. All splices shall be enclosed within a valve box.

F. **Hydraulic control tubing.**

1. For hydraulic control systems, use a water supply that is filtered and free of deleterious materials, as defined by the hydraulic control system manufacturer. Install a backflow prevention device where the hydraulic control system is connected to potable water supplies.

2. Install tubing in trenches freely and spaced so that it will not rub against pipe, fittings, or other objects that could score the tubing, and with a minimum 12-inch (305 mm) diameter loop at all turns and connections. Provide a minimum depth of cover of 12 inches (305 mm).

3. Connect tubing with couplings and collars recommended by the tubing manufacturer. All splices shall be made in valve boxes. Prefill tubing with water, expelling entrapped air and testing for leaks prior to installation.

Install exposed tubing in a protective conduit manufactured from Schedule 40 UV protected PVC or electrical conduit.

PART VI: TESTING & INSPECTIONS

A. **Purpose.** All materials and installations covered by the Irrigation Code shall be inspected by the governing agency to verify compliance with the Irrigation Code.

B. **Rough inspections.** Rough inspections will be performed throughout the duration of the installation. These inspections will be made by the governing agency to ensure that the installation is in compliance with the design intent, specifications, and the Irrigation Codes. Inspections will be made on the following items at the discretion of the governing agency:

   1. Sprinkler layout and spacing: This inspection will verify that the irrigation system design is accurately installed in the field. It will also provide for alteration or modification of the system to meet field conditions. To pass this inspection, sprinkler/emitter spacing should be within ± 5 percent of the design spacing.

   2. Pipe installation depth: All pipes in the system shall be installed to depths as previously described in this code.

   3. Test all mainlines upstream of the zone valves as follows:

      a) Fill the completely installed pipeline slowly with water to expel air. Allow the pipe to sit full of water for 24 hours to dissolve remaining trapped air.

      b) Using a metering pump, elevate the water pressure to the maximum static supply pressure expected and hold there for a period of 2 hours, solvent-weld pipe connections shall have no leakage.

      c) For gasketed pipe main lines add water as needed to maintain the pressure. Record the amount of water added to the system over the 2-hour period.

      d) Use the following formulas to determine the maximum allowable leakage limit of gasketed pipe.

DUCTILE IRON:

$$L = \frac{SDP}{133,200}$$

PVC, GASKETED JOINT:

$$L = \frac{NDP}{7,400}$$

Where:

L = allowable leakage (gph),

N = number of joints,

D = nominal diameter of pipe (inches),

P = average test pressure (psi), and

S = length of pipe (fi).

e) When testing a system which contains metal-seated valves, an additional leakage per closed valve of 0.078 gph/inch of nominal valve size is allowed.

C. **Final inspection.** When the work is complete the contractor shall request a final inspection.

1. Cross connection control and backflow prevention.

   a) Public or domestic water systems: Check that an approved backflow prevention assembly is properly installed and functioning correctly. Review the location of the assembly to check that it is not creating a hazard to pedestrians or vehicular traffic.

   b) Water systems other than public or domestic water systems: Check that the proper backflow prevention assemblies are provided.

   c) All assemblies that can be, will be tested by a technician certified for backflow testing by a State recognized certifying board prior to being placed into service.

2. Sprinkler coverage testing.

   a) All sprinklers must be adjusted to minimize overspray onto buildings and paved areas. Minor tolerances shall be made to allow for prevailing winds.

   b) All sprinkler controls must be adjusted to minimize runoff of irrigated water. Water application rates shall not exceed the absorption rate of the soil.

   c) All sprinklers must operate at their design radius of throw. Nozzle sizes and types called for in the system design must have been used. All nozzles within the same zone shall have matched precipitation rates unless otherwise directed in order to increase efficiency by adjusting the nozzle selection to match site conditions.

   d) Spray patterns must overlap as designed (a.k.a. head to head coverage) or placed to achieve the highest possible distribution uniformity using the manufacturer's specifications.

e) Sprinklers must be connected, as designed, to the appropriate zone.

f) Sprinkler heads must operate within 20 percent of the optimum operating pressure but not more than the maximum nor less than the minimum guidelines as specified by the manufacturer. If the dynamic water pressure at the site's water source(s) is too low to achieve this pressure range at the sprinklers, a booster pump or alternate source shall be required. If the dynamic water pressure at the site's water source(s) is too high to achieve this pressure range at the sprinklers, a pressure regulating device shall be required at either the source, the zone valve, or the sprinklers, or any combination there of.

D. **Site restoration.**

1. All existing landscaping, pavement, and grade of areas affected by work must be restored to original condition or to the satisfaction of the governing authority.

Verify that the pipeline trenches have been properly compacted to the densities required by the plans and specifications.

E. **Record Drawings.**

1. A record drawing shall be required of all irrigation systems installed on commercial and residential developments and shall contain the following information:

a) Location, type pressure and maximum flow available of all water sources. Include limitations like days of week watering requirements.

b) Location type and size of all components including sprinklers, microirrigation, main and lateral piping, master valves, valves, moisture sensors, rain sensors, controllers, pump start relays, backflow devices, pumps, wells, etc.

c) The flow rate, application rate (inches per hour), and the operating pressure for the sprinklers and microirrigation within each zone.

d) An irrigation schedule for each zone, for each season (monthly is preferred), indicating the frequency and duration each zone should operate to meet the plant water requirements without rainfall and stay within the hydraulic capacities of the sprinkler system installed.

e) The name, address, phone, email, professional license or certification number of the installation contractor.

f) Date of installation.

g) Irrigation system maintenance schedule that shall include, but is not limited to the following:

1. routine visual inspections (at least 4 per year);
2. adjustments to components to keep sprinklers straight, at the right height;
3. aligned and unobstructed nozzles and screens cleaned;
4. filters cleaned and sensors monitored,; and
5. pressures and flows at the source and sprinklers are correct for original design.

F. **Irrigation System Maintenance.**

1. Repairs to all irrigation components shall be done with originally installed components, equivalent components or those with greater efficiency.
2. The operation of the irrigation system outside of the normal watering window shall be allowed for evaluating, maintaining or repairing the system or its components.

G. **G. Irrigation system management.**

1. The frequency (times per week/month) and duration (minutes/hours) of the operation of each zone shall be adjusted and operate in order to meet the water needs of the plants within each zone as a supplement to rainfall. Adjustments shall be made a minimum 4 times per year to match the seasonal changes of the plants and the operational restrictions.
2. It is recommended that the schedule be adjusted monthly or controllers be properly installed and programmed to automatically adjust to maximize water savings.

IRRIGATION
PLAN REVIEW CHECKLIST

CITY OF ALLEN

★*This checklist must be submitted with a Building Permit Application for any IRRIGATION SYSTEM.*

Job Information		
Property Address:	**Suite #**	**Contractor:**
☐ **Residential** ☐ **Commercial** ☐ **Multi-Family** ☐ **HOA** ☐ **Other** **Number of Zones**____________________		
Irrigator's Name and License #:		
Submittal Requirements		
The following documents must be submitted with application: ☐ **Building Permit Application (2 copies)** ☐ **Plan Review Checklist (1 copy)** ☐ **Construction Plans (2 copies),** ***1"=10' or larger***		

Check which of the following have been included:

Y / N

☐ ☐ Plan designed according to all standards of TCEQ 30 TAC 344-Landscape Irrigation.

☐ ☐ Scale, north arrow, legend, irrigator's seal and signature, landscape architect seal and signature or licensed plumber signature and license number present on plan. Plan scale 1" = 10' or larger.

☐ ☐ All irrigated and non-irrigated areas clearly shown on plan.

☐ ☐ Separate zones based on plant material type, microclimate, topography, soil and hydrologic requirements.

☐ ☐ All non-turfgrass areas are designed with drip irrigation and/or pressure compensating tubing.

☐ ☐ All landscaped areas (including turfgrass) located between the sidewalk and curb/pavement edge are designed with drip irrigation and/or pressure compensating tubing.

☐ ☐ Turf areas utilizing irrigation rotors are designed using low-angle nozzles.

☐ ☐ All components are designed to not exceed manufacturer's published performance limitations.

☐ ☐ All components are clearly noted on plan: backflow prevention device, controller, rain/freeze sensor, all water emission devices, zone valves, isolation valve, pressure regulating component, main line and lateral piping, Y-Type strainer.

☐ ☐ Sprinkler head radius must be shown on plans.

☐ ☐ System is designed to provide a distribution uniformity of .63 DU_{lq} or better.

Applies to Single-Family Homes Only:

☐ ☐ System has separate zone for a drip system around the foundation.

☐ ☐ All zones must be identified such as: front yard, right side, foundation drip, parkway drip, etc.

Applies to Non-Single Family Developments Only:

☐ ☐ All landscape areas that are less than ten ft. in width and adjacent to impervious surfaces, landscape islands 200 sq. ft. or less in area are designed with drip irrigation and/or pressure compensating tubing.

Applicant's Signature:____________________________ **Date:** _____________________

Print Name:____________________________________**Contact Phone #:**___________________

By signing this you have agreed that all required information has been submitted. Failure to submit all information may result in a delay of your permit being issued.

IRRIGATION REVIEW & INSTALLATION REQUIREMENTS

IRRIGATION SYSTEM DESIGN:

In order to ensure proper design and installation of irrigation systems and implement the City of Allen's water conservation initiatives, new and renovated landscape irrigation systems must comply with the City of Allen and State design and installation requirements as defined by Texas Commission on Environmental Quality (TCEQ) 30 TAC 344-Landscape Irrigation. These rules are available on TCEQ website: http://www.tceq.state.tx.us/assets/public/compliance/compliance_support/regulatory/irrigation/forms_li/rul esforregguid_063008.pdf

In addition to the requirements of 30 TAC 344, the City of Allen requires the following:

- Plans shall be sealed by a licensed irrigator, landscape architect or licensed plumber to standards listed in 30 TAC 344.
- Plans must include and show location of an automatic controller and sensors that prevent the operation of irrigation during rainfall or in freezing weather.
- Sprinkler head radius must be shown on plans.
- Plans must designate turf and non-turf areas. All non-turf landscape areas shall be designed with drip irrigation and /or pressure compensating tubing (no above-ground spray).
- All landscaped areas (including turfgrass), regardless of size, located between the sidewalk and curb/pavement edge for any development shall be designed with drip irrigation and/or pressure compensating tubing (no above-ground spray) and must be noted on plan.
- All drip irrigation and/or pressure compensating tubing shall be designed and installed according to manufacturer's specifications. For subsurface installation, application rate shall not exceed .21 inches per hour.
- Turfgrass areas utilizing irrigation rotors are to be designed and installed using low-angle nozzles.
- Plans must indicate the designed distribution uniformity for the system. Irrigation heads shall be installed to provide maximum distribution uniformity. The system shall be designed to provide a distribution uniformity of 63 percent DU_{lq} or better.
- The irrigation design shall prevent overspray on impervious surfaces and excessive runoff.
- ***Single-family homes*** shall have separate zones for a drip system around the foundation and must be noted on the plan.
- ***Non-single family developments*** All landscape areas that are less than ten feet in width and adjacent to impervious surfaces, and landscape islands 200 sq. ft. or less in area shall be designed with drip irrigation and/or pressure compensating tubing (no above-ground spray).
- Irrigation systems that vary from the standards of this Code and are designed to minimize water usage may be reviewed and approved by the Parks and Recreation Department.

Under the water conservation plan and drought contingency plan there are limits to the use of sprinkler systems. If a new construction building or new home requires more than two days per week watering to establish new sod or landscape, the contractor/owner must apply for a variance. There is no guarantee the variance will be granted if under the drought contingency portion of the plan. To apply for a variance, visit: cityofallen.org/watervariance. For more information on water conservation, please contact gdonaldson@cityofallen.org.

IRRIGATION AUDIT REQUIRED (COMMERCIAL ONLY):

A certified landscape irrigation auditor shall conduct an irrigation audit inspection after installation and before final inspection. The inspection must include an evaluation of the system distribution uniformity and the design and installation requirements of City code. A completed audit form must be submitted along with the backflow test report before scheduling the final inspection (see attached Irrigation Audit Form).

When existing irrigation systems are expanded by more than 25% (25% of the land area covered by the system); or more than 25% (25% of the land area covered by the system) of the irrigation system is replaced, the portion being expanded or replaced shall meet the current Code requirements.

IRRIGATION SYSTEM INSPECTION REQUIRED:

A City inspection of the irrigation system must be requested through the Building Inspection Department by calling 214-509-4149. The permit, approved plans, a copy of the required maintenance checklist with owner or owner representative signature, and a licensed irrigator or licensed installer/technician who provided supervision of installation must be on site for the inspection. In the case of ***non-single family developments***, the inspection form documenting the evaluation of the system distribution uniformity must also be on site for the inspection. The system inspection will consist of “open trench” inspection of all piping, wiring, and components of the mainline from the point of connection of the water supply, up to and including the first electric remote valve with electrical wire and connection exposed. All lateral lines, pop-up heads and other mainline or valves do not need to be exposed for this inspection. In areas, where required, a portion of the drip line or pressure compensating tubing shall be left exposed for inspection. The inspection will include a visual check of each zone for performance during a brief operation run time.

ADDITIONAL INFORMATION

City Water Pressure: Varies; if more than 80 psi, a pressure reducing valve shall be installed
Meter Size: Systems should be sized with a 5/8” meter not to exceed 15 GPM flow
Line to House: ¾” (usually)
Location of Line from Street: Contact your builder
Fee: Commercial permit - $10 per zone, $500 max/Residential permit - $75
Plumbing Requirements:

- Materials shall be those which are included in the 2015 International Plumbing Code or in the 2015 International Residential Code
- Atmospheric vacuum breakers shall not be subject to continuous pressure and must be installed at least 6” above grade. If pressure type vacuum breakers are used, they must be installed at least 12” above grade
- Other listed backflow preventers (such as double check valve assemblies), shall be installed in accordance with their listing and according to 30 TAC 344 from TCEQ.
- Minimum of 2” space from gravel to double check
- Minimum of 6” gravel base in bottom
- Before excavation or boring call: Dig Tess at 1-800-344-8377.

CITY OF ALLEN

Irrigation Inspection Form

Please return completed form to address listed on the bottom of page.

Property Information:

Name of Property: ______________________________________

Address of Property: _____________________________________

Allen, Texas Zip: _________________

Water utility account number: ______________________

Responsible Party (Person with decision making authority regarding property)

Name:____

Address:____

City:________________State: Zip: _______________

Phone number: ______________________________

Email: ____

Information of person conducting irrigation system inspection:

Name:____

Address:____

City:_______________State:_____Zip: _________

Phone number:______________________________TX LI # ______________

Email: ____

*****Certified Irrigation auditor with:_____Texas A&M_____Irrigation Association

**** A copy of certification document from either Texas A&M or the Irrigation Association must be on file. If this is your first time to perform an audit, enclose one copy with this form.***
If licensed irrigator is found to be falsifying information, a report will be made to TCEQ.

Community Services 305 Century Parkway Allen, Texas 75013 214-509-4500
Attn: Gail Donaldson gdonaldson@cityofallen.org Fax: 214-509-4590

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Irrigation Inspection Form Page 2

Meter Size:__________Meter Number:__________________Irrigation only? YES   NO

Controller Information* (Brand, model):

____

Cross Connection Control device (Brand, type, size): _____________________________

Rain/ Freeze Sensor Brand:________________________Working?   YES   NO

TOTAL Number of zones:_______Irrigation day program (circle all days)   M   T   W   Th F S Su

Type of irrigation on controller (all that apply):   Spray   Rotor   Bubblers   Drip

System Analysis: All sunken, clogged, misaligned, broken, blocked, or otherwise problem heads have been corrected to maximize efficiency **<u>before</u>** this system analysis was performed. All zones are in most efficient working order and a zone was chosen that most represents the irrigation coverage of 60% of the property turfgrass area. Pressure reading was performed on at least one irrigation head in the zone. An IA method catch-can test was performed to determine PR and DU and results are recorded below. *(Do not audit drip zones)*

Representative Zone information:

Soil Type:________Plant Type(s):___________________

Zone #_______Type of irrigation heads (circle one):   Spray   Rotor   Number of heads:______

Nozzle type (specialty nozzle?):____

Number of start times for zone:______Minutes programmed _________

Actual Pressure reading (on irrigation head)______psi

Precipitation Rate (PR):_______Inches per Hour

Distribution Uniformity (DU_{LQ}): _______

Signature of Certified Irrigation Auditor:____________________________________(include copy of certificate from either Texas A&M or Irrigation Association if not on file)

Date: ___________________

If property has more than one controller, use additional form for each controller. A minimum of one zone per controller must be audited.

Community Services 305 Century Parkway Allen, Texas 75013 214-509-4500
Attn: Gail Donaldson gdonaldson@cityofallen.org Fax: 214-509-4590