Water Efficient Guidelines for

New Development

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Submitted to:

EASTERN MUNICIPAL WATER DISTRICT
SINCE 1950

Submitted by:

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Introduction to the Water Efficient Guidelines

Goal of guidelines project

The goal of this project was to develop a set of voluntary guidelines for new development in the Eastern Municipal Water District (EMWD) service area that, if implemented, will reduce overall water use in new buildings beyond what is currently required by state and local codes and requirements. The focus of this guidebook is on incentive-driven, cost-effective, voluntary water efficiency measures for new residential development. It is anticipated that the majority of new construction in EMWD's in the coming years will consist of single and multi-family housing.

The focus of these guidelines is on incentive-driven, cost-effective, voluntary water efficiency measures for new residential development.

Information on water efficiency in new non-residential buildings (i.e. the commercial, industrial, and institutional sectors) can be found in the *WaterSmart Guidebook for New Business* created by the East Bay Municipal Utility District. This WaterSmart Guidebook is available for free download here: http://www.ebmud.com/for-customers/conservation-rebates-and-services/commercial/watersmart-guidebook.

The Eastern Municipal Water District (EMWD) was organized as a Municipal Water District in 1950 for the primary purpose of importing Colorado River water to its service area in order to augment local water supplies. Its primary water supplier is the Metropolitan Water District (MWD) of Southern California, which provides up to 75% of its water supply. As a Municipal Water District operating under state law, the publicly elected Board of Directors is legally responsible for its organization and performance.

How to Use the EMWD Water Efficiency Guidelines

The EMWD Water Efficiency Guidelines are divided into two primary sections – (1) indoor guidelines; and (2) outdoor guidelines.

1. **Indoor guidelines** – designed primarily for builders, developers, and those involved in the design and construction of residential housing who make decisions about what appliance and fixtures are installed. The indoor guidelines are also applicable to existing residents who may be seeking to improve water efficiency in their home or apartment.
2. **Outdoor guidelines** – designed primarily for residents, landscape architects and designers, builders, and others who make decisions about creating landscapes in new residences. The outdoor guidelines are also applicable to existing residents seeking to re-develop their landscape.

Water Efficiency Requirements for New Development

Indoor

The *California Green Building Standards Code of California Code of Regulations, Title 24, Part 11* (CALGreen) has been adopted across California and EMWD service area. In addition to requirements for storm water drainage, CALGreen includes a number of significant water efficiency provisions that impact residential and non-residential development and forms the baseline condition for indoor efficiency requirements in the EMWD service area.

CALGreen Indoor Residential Water Efficiency Requirements

A goal of the CALGreen building standards regarding indoor water use is to try and assure that new residential construction achieves at least a 20% reduction compared to the baseline use for the typical fixtures and appliances found in existing residences. This is accomplished through a series of mandatory requirements described in Table 1 below.

Table 1: CALGreen indoor residential water efficiency requirements

Category	CALGreen Requirement
Toilets	1.28 GPF (includes single flush and dual flush fixtures with an effective flush volume of 1.28 gallons)
Bathroom faucets	1.5 GPM maximum flow rate
Kitchen faucets	1.8 GPM maximum flow rate
Showerheads	2.0 GPM maximum flow rate at 80 PSI

CALGreen also includes several water efficiency components that become mandatory only if the builder/developer chooses to install the particular water using appliance (e.g. dishwasher or clothes washer). These requirements are described in Table 2 below.

Table 2: CALGreen residential clothes washer and dishwasher requirements

Category	CALGreen Requirement
Clothes washer	If installed by the developer/builder, clothes washers shall be ENERGY STAR rated which currently has a maximum volume allowance of 15 gallons per load or a water factor of 4.0 or less
Dishwasher	If installed by the developer/builder, dishwashers shall be ENERGY STAR qualified and not use more than 5.8 gallons per cycle. See http://www.cee1.org/

In an effort to reduce the volume of water that is lost/wasted while waiting for hot water to arrive at a fixture, CALGreen includes a detailed set of requirements related to the hot water distributions system in new residential construction. The CALGreen codes states,

"Where the hot water source is more than 10 feet from a fixture, the potable water distribution system shall convey hot water using one of the following methods:

- *A central manifold plumbing system with parallel piping configuration ("home-run system") is installed using the smallest diameter piping allowed by the California Plumbing Code or an approved alternate.*
- *The plumbing system design incorporates the use of an on-demand controlled circulation pump.*
- *A gravity-based hot water recirculation system.*
- *A timer-based hot water recirculation system.*
- *Other methods approved by the enforcing agency."*

Outdoor

Landscape and irrigation efficiency requirements typically apply across all customer categories and impact both residential and non-residential development alike.[1] The combination of the California Model Landscape Ordinance (AB 1881) provisions and EMWD's water budget rate structure that provides an outdoor budget allocation of 70% of ET for landscapes installed after 1/1/2011 are designed to help ensure that all new landscapes are designed and installed to be water efficient and then irrigated in an efficient manner.

AB 1881 – Model Water Efficient Landscape Ordinance 2006

Assembly Bill (AB) 1881, the Water Conservation in Landscaping Act was passed by the California legislature in 2006. AB 1881 requires the California Department of Water Resources (DWR) to update the California Model Landscape Ordinance established through AB 325 in accordance with specified requirements, reflecting many of the recommendations from the AB 2717 Task Force.

Under AB 1881, local agencies were required to adopt the updated Model Ordinance (or a stricter local landscape ordinance) by 1/1/2010. The Model Ordinance establishes a formal structure for planning, designing, installing, maintaining, and managing water efficient landscapes in new construction and rehabilitated projects and establishes provisions for water management practices and water waste prevention on existing landscapes.

Key Provisions of California Water Efficient Landscape Ordinances

A summary of some of the key provisions in the Model Landscape Ordinance is presented in Table 3.

[1] Differences in the water efficiency requirements for residential and non-residential landscapes are noted when they exist.

Table 3: Key provisions of the California Model Landscape Ordinance (http://www.water.ca.gov/wateruseefficiency/landscapeordinance/)

Category	California Model Ordinance (January 1, 2010)
Applicability	• Public or contractor installed or rehabilitated landscape area >= 2,500 SF that require a landscape permit, plan check or design review • New construction and rehabilitated landscapes installed or hired by homeowners with area >=5000 sf • Existing landscapes greater than 1 acre required to be audited
Landscape Design	• Maximum applied water allowance (MAWA) set at 70% of ET_o • Any plant is OK if the Estimated Total Water Use <= MAWA • Soil management reports required • Includes detailed requirements for landscape designs • Landscape water meters recommended • Use of Smart Irrigation Controller[2]
Compliance Certification	• Written documentation package

EMWD Landscape Water Budget Allocation for New Development

In EMWD's service area, an annual water budget allocation is established for each customer based on the water requirements of the building, occupants, and landscape.[3] Budget variances are offered and approved where warranted.

All residential and landscape customers are on a water budget-based tiered rate structure. Each customer's total water budget includes indoor and outdoor water budgets. EMWD offers a Water Budget and Bill Estimator on the web site: http://www.emwd.org/index.aspx?page=291.

Water budgets are designed to give customers water they need for both indoor and outdoor uses. Tiered water rates reward customers who use water efficiently and discourage water waste.

[2] See www.SoCalWaterSmart.com for qualifying products

[3] To get more information about how water budgets are established in the EMWD visit http://www.emwd.org/index.aspx?page=291

New Customers Are Expected to be More Efficient

To enforce water use efficiency in new development, EMWD has **lowered** the water budget allocations for new development. Any residential or dedicated landscape account installed after December 31, 2010 will have an outdoor budget allocation based on only 70% of reference evapotranspiration (ET_o). This is compared with an allocation based on up to 100% of ET_O for older accounts.

This water budget allocation for new development acts in concert with locally adopted landscape ordinances which vary to some degree across the EMWD service area, depending upon the local jurisdiction. The 70% EMWD water budget allocation acts as an enforcement mechanism on the water use of new landscapes. The local landscape ordinances strive to ensure that new and rehabilitated landscapes require no more water than 70% of ET_o. The EMWD water budget establishes a significantly higher water rate if usage exceeds the 70% allocation. Usage that exceeds the water budget allocation is billed in steeply increasing tiers. This in turn provides financial resources to EMWD that can be targeted at reducing outdoor water use and obtaining additional water supply.

Beyond CALGreen – Greater Water Efficiency

An important goal of this study was to look beyond the status quo to determine if voluntary water efficiency in new buildings beyond what is currently specified in CALGreen is possible and cost-effective. The research shows that even after applying the CALGreen and applicable landscape ordinance standards, there are still some areas that can be addressed to reduce household water use beyond what just the requirements of the ordinances can achieve.

Greater water efficiency, above and beyond CALGreen, can be accomplished through voluntary measures listed below and described in greater detail later in this document.

- **Toilets** - Current CALGreen standard = 1.28 gallons per flush. Achieve a 22% water savings by installing a WaterSense rated 1.0 gallons per flush toilet.
- **Clothes washers** - Current CALGreen standard = If installed by the developer/builder, clothes washers shall be ENERGY STAR rated which currently has a maximum volume allowance of 15 gallons per load. Achieve a 20% water savings by installing a high efficiency clothes washer with a volume of 12 gallons per load or less. Rebates are only available for clothes washers with a water factor of 4.0 or less.
- **Showers** - Current CALGreen standard = 2.0 GPM maximum flow rate at 80 psi. Greater efficiency available with a 1.5 - 1.75 GPM max flow rate showerhead at 80 psi.
- **Lavatory faucets** - Current CALGreen standard= bathroom - 1.5 GPM max. Reduce water use by installing 0.5 GPM max aerators in the bathroom.
- **Outdoor/Irrigation** - Status quo = AB 1881 and locally adopted landscape ordinances, 70% of ET water budget allocation from EMWD. Water savings are possible through installation of a landscape that requires less than 70% of ET water budget allocation.

Each of these voluntary measures is described in more detail later in this guidebook.

If all new housing in EMWD were to implement the recommendations in this guidebook fully, it is estimated that 14.5 billion gallons of water could be conserved by the year 2035.

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EMWD Conservation Programs

Eastern Municipal Water District understands that no one can control what water Mother Nature provides, and there can be little control over environmental issues that affect the ability to import water. We do have the power to control how we use water. EMWD's conservation programs encourage existing and future customers to make water efficiency a way of life through installation of efficient fixtures and appliances, water budgets to help manage outdoor irrigation, and water use efficiency regulations.

Rebates and Incentives

EMWD seeks to encourage adoption of the voluntary guidelines described in this publication by offering financial incentives to customers who wish to implement specific water efficiency measures. EMWD offers a wide variety of rebates and incentives for installation of water efficient fixtures and appliances. Currently EMWD offers the following rebates and incentives:

- Residential rebates for a wide variety of measures through www.socalwatersmart.com. Check the web site to determine which incentives are applicable.
- Direct installation of a weather-based "smart" irrigation controller. Get application information here - http://www.emwd.org/modules/showdocument.aspx?documentid=996
- Free water conservation information packet and free outdoor water conservation kit - http://www.emwd.org/index.aspx?page=83

EMWD frequently updates conservation incentive program offerings. Get the latest information about conservation offerings; learn about available rebates and incentives, and applications for conservation program directly at- http://www.emwd.org/index.aspx?page=83. Additional rebates may also be available through local energy providers.

Water Use Checkup for New Residents

New in town? EMWD wants to help new residents use water efficiently. EMWD offers new residents who have exceeded their water budget a "water use checkup" during the first four months of occupancy. The checkup includes a home visit from EMWD staff where they will:

- ✓ Review the EMWD water budget established for the home
- ✓ Inspect fixtures and appliances to ensure indoor efficiency
- ✓ Check the programming of the irrigation controller (if applicable)
- ✓ Discuss landscaping options for the backyard

A water use checkup from EMWD can set new residents on the path for long-term water conservation savings.

Understanding Your Water Bill

EMWD measures water in Billing Units (BU), where 1 BU = 100 cubic feet of water = 748 gallons of water. If you use 5 billing units of water in one month that is equivalent to 5 x 748 = 3,740 gallons. It is easy to convert from billing units to gallons; simply multiply the number of billing units by the conversion factor of 748 gallons. A simple calculator for converting cubic feet into gallons can be found here - http://www.metric-conversions.org/volume/cubic-feet-to-us-liquid-gallons.htm. Many similar unit conversion apps are available on the Internet.

EMWD bills customers monthly for water consumption using a tiered, increasing block rate structure coupled with a water budget that is customized for each property. Water rates are adjusted regularly and information on the current water rates for EMWD can be found here - http://www.emwd.org/index.aspx?page=274

2013 EMWD residential water rates start at $1.62 per BU and increase up to $9.71 per BU in the top tier.

Additional information on EMWD's water budgets and tiered rates can be found here - http://www.emwd.org/index.aspx?page=291

What if my Water Budget Isn't Set Properly?

EMWD offers water budget variances for customers with special circumstances. These circumstances could include:

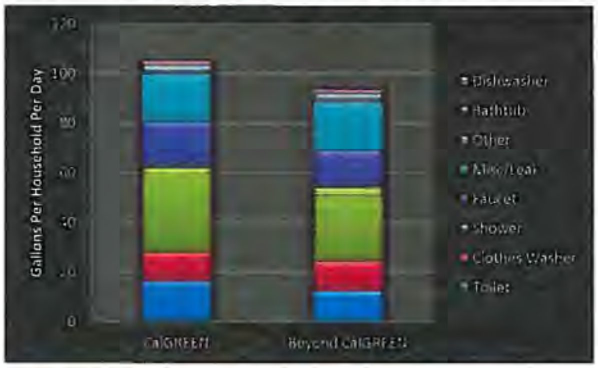
- More residents living in the house than average/default
- A licensed elder or child care facility is operated (in a residential unit)
- Someone in the home has special medical needs that require additional water
- Additional or new irrigated landscape area has been added
- Pools (filled once every five years)
- Large animals (weighing over 100 pounds each)
- Other Instances where an increased allocation on a permanent or temporary basis may be considered.

Learn more and apply for a variance from EWMD here - http://www.emwd.org/index.aspx?page=86

Indoor Guidelines and Recommendations

Indoor Water Use Patterns

Applying the voluntary measures recommended in this guidebook can help reduce indoor water use by an estimated 11% per household over the current CALGreen requirements – without requiring any changes in behavior patterns. A comparison of the estimated indoor average daily per household water use is shown in the bar chart. The water savings in this example are achieved through improved efficiency in the toilet, shower, and faucet categories.



Estimated indoor average daily per 3 person household water use

The EMWD currently sets indoor water budgets based on water use estimated at 60 gallons per capita per day (GPCD). Homes built to meet the current CALGreen specification are expected to have water demands as low as 35.0 GPCD for a household of 3 people. Homes that include the efficiency recommendations in this guidebook are expected to have water demands of only 31 GPCD. Compared with the current EMWD water budget allocation of 60 GPCD, new homes may use substantially less water indoors. It should be kept in mind that using less water indoors does not reduce the utility or comfort of the residential setting; it merely accomplishes the necessary services that water provides to a residence with less water. This leaves more water available for other uses.

Toilets – 1.0 Gallons per Flush (GPF) or better

- Current CALGreen standard: 1.28 GPF.
- EMWD Water Efficient Guidelines recommendation: 1.0 GPF, WaterSense labeled toilet or better.

If toilets rated at 1.0 GPF (or even as low as 0.8 GPF) are installed water savings (beyond CALGreen) of 0.28 GPF or more could be realized. A typical household of 3 people averages about 12 flushes per household per day, so a savings of 0.28 GPF could results in water savings of 1,200 gallons/year (1.6 CCF/yr).

If all new housing in EMWD were to install 1.0 gpf toilets during the construction phase, it is estimated that 1.1 billion gallons of water could be conserved by the year 2035.

The 1.0 GPF toilets recommended here are readily available from big box retailers and plumbing supply outlets. The flushing performance of these fixtures has been proved through MaP Testing and a high scoring 1.0 GPF toilet is capable of removing waste just as effectively as a comparable 1.28 GPF toilet.[4] Recent research on drain line carry indicates 1.0 GPF toilets are not likely to clog properly designed sewer lines and are perfectly acceptable for residential applications.[5]

Installing a 1.0 GPF toilet is a cost-effective efficiency measure that will save water and money for years to come.

Equipping a new home with 1.0 GPF toilets is estimated to save $4.46/per household per year on water bills over a 10-year expected useful life of the product. The benefit/cost ratio of installing a 1.0 GPF toilet, assuming $25 incremental cost difference, is 1.6 indicating this is a cost-effective measure to implement from the perspective of the household. If the useful life of the toilet is greater than 10 years (i.e. the toilet lasts longer than 10 years while still delivering water savings), the benefits of the efficient fixture become even greater.

- Learn more about 1.0 GPF and lower volume toilets here - http://www.home-water-works.org/indoor-use/toilets
- Search test scores and ratings of 1.0 GPF and lower volume toilets here - http://www.map-testing.com/about/maximum-performance/map-search.html

Clothes Washer – High Efficiency

- Current CALGreen standard: *If* installed by the developer/builder, clothes washers shall be ENERGY STAR rated with an average volume allowance of 15 gallons per load.
- EMWD Water Efficient Guidelines recommendation: Install an ENERGY STAR rated clothes washer with an average volume allowance of 15 gallons per load or less.[6]

ENERGY STAR rated high efficiency clothes washers save an average of nearly 12 gallons per household per day vs. standard washers. High efficiency washers are readily available from all major manufacturers and these products have achieved a wide degree of acceptance in the residential market.

In a 2011 research study, high efficiency clothes washers were installed as part of a retrofit and these efficient machines used an average of 15 gallons per load

The useful life cost savings for a high efficiency clothes washer are estimated to be $217 based on water efficiency alone. Energy efficiency increases the benefit.

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[4] Maximum Performance (MaP) Testing provides flushing performance scores for more than 2,200 tank-type toilets and is updated monthly. The MaP rating system has been endorsed by consumer groups, manufacturers, retailers, architects, and the US EPA through its WaterSense initiative.

[5] Plumbing Efficiency Research Coalition (2012). The Drainline Transport of Solid Waste in Buildings. Chicago, IL.

[6] http://library.cee1.org/content/cee-residential-appliance-committee-clothes-washer-specification-january-1-2011. Clothes washers must have a maximum water factor (WF) of 4.0 to qualify for a rebate.

of clothes (matching the current CALGreen specification).[7] In 2013, there are a wide variety of residential clothes washers on the market that use *less* than 15 gallons per load on average.

Front-loading clothes washers are generally more efficient than top-loaders, although manufacturers have introduced some new high-efficiency top-loading models that are as efficient as some front-loaders. Until recently, top-loaders were much more common than front-loaders, but front-loaders now make up about half of annual sales.

Installing a high-efficiency clothes washer is cost effective from the customer perspective. The useful life cost savings are estimated to be $217 based on water efficiency alone. These machines also use substantially less energy and the energy savings increase cost effectiveness. The benefit-cost ratio for upgrading to a high efficiency washer is much greater than 1 indicating a high level of cost effectiveness.

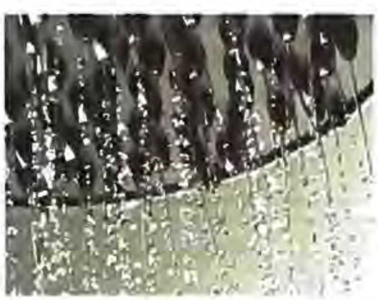
It is estimated that a household of 3 people could conserve 5,400 gallons of water per year by selecting a high efficiency clothes washer over a standard top loading machine. If all new housing in EMWD were to include a high-efficiency clothes washer, it is estimated that 4.4 billion gallons of water could be conserved by the year 2035.

EMWD and partnering agencies offer rebates for the purchase of a high efficiency clothes washer.

- Learn more about the rebate program here – http://www.socalwatersmart.com/
- Access a list of clothes washers that qualify for a rebate here - http://www.socalwatersmart.com/images/PDFs/qualifying_list_hecw.pdf
- Get more information about high efficiency clothes washers from the Appliance Standards Awareness Project here - http://www.appliance-standards.org/product/clothes-washers

Showers and Showerheads

- Current CALGreen standard: 2.0 gallons per minute (GPM) maximum flow rate at 80 pounds per square inch (PSI)
- EMWD Water Efficient Guidelines recommendation: Install 1.5 - 1.75 GPM maximum flow rate showerhead at 80 PSI



Showering consumes over 30 gallons per household per day and the water savings from reducing shower volumes could be significant – comparable to the savings available from high efficiency clothes washers.

Showerheads are inexpensive and the additional cost of selecting a 1.75 GPM model over a 2.0 GPM model is typically less than $15 and often $0. The potential annual water savings from a low flow showerhead are estimated to be about 500 gallons per household per year. If all new housing in EMWD were to have 1.5 GPM showerheads installed during the construction

[7] DeOreo, W. B., et al. (2011) Analysis of Water Use in New Single Family Homes. Aquacraft, Inc. Water Engineering and Management. Boulder, CO.

phase, it is estimated that 400 million gallons of water could be conserved by the year 2035. Reducing shower volumes has the added benefit of conserving energy by reducing the volume of hot water consumed.

Ultra-low flow showerheads are available at all big box home centers and local plumbing supply outlets. The rated flow rate of the showerhead should be clearly labeled on the packaging and on the fixture itself.

Simply reducing the flow rate of showers by installing an ultra-low flow showerhead does not guarantee significant water savings, because sometimes the duration or frequency of showering increases if the flow rate is reduced (DeOreo, et. al. 2011). The key to achieving additional savings from showers appears to be in motivating people to take shorter showers. Reducing the duration as well as the flow rate of showers will result in measurable water savings. Broadly reducing shower durations could be a difficult behavior change to achieve. Some elements of showering, such as rinsing hair, require a certain minimum volume of water.

Reducing the duration as well as the flow rate of showers will result in measurable water and energy savings.

- Get more information on showers, showering, water use, and behavior here - http://www.allianceforwaterefficiency.org/Residential_Shower_Introduction.aspx
- Learn about WaterSense labeling of showerheads here - http://www.epa.gov/WaterSense/products/showerheads.html

Bathroom Faucets – 0.5 GPM aerators[8]

- Current CALGreen standard: 1.5 GPM maximum flow aerators.
- EMWD Water Efficient Guidelines recommendation: Install 0.5 GPM maximum flow aerators in all lavatory/bathroom sink.

Reducing the faucet flow rate in lavatories and bathrooms is a proven, low cost water efficiency measure. Current federal plumbing codes mandate 0.5 GPM aerators for commercial lavatories. These products are proven in the field and can easily be adapted for use in the residential setting.

Under CalGREEN all new homes will be equipped with structured hot water plumbing systems. This could result in faucet and shower savings from reducing the time spent waiting for hot water.

Additional options are available including a shut-off device on the faucet aerator and hands free faucet control that might reduce the amount of time faucets are left running. Under CALGreen all new homes will be equipped with structured hot water plumbing systems. This could result in reduced faucet use (and shower use) by reducing the time spent waiting for hot water to reach the faucets.

[8] The CALGreen standard for kitchen faucet aerators is 1.8 GPM. Reducing the flow rate at the kitchen sink below this level is not recommended because many kitchen faucet uses require filling fixed volumes.

Faucet aerators are inexpensive and there is typically no additional cost associated with selecting a 0.5 GPM model vs. a higher flow model. Many water providers offer low-flow faucet aerators as a free incentive, but installing 0.5 GPM aerators will be cost effective from the customer perspective even if no incentive is given. Energy savings from reduced hot water use in the bathroom increase the benefits.

It is estimated that a household of three people could conserve 750 gallons of water per year by installing 0.5 GPM faucet aerators. If all new housing in EMWD were to have 0.5 GPM faucet aerators installed during the construction phase, it is estimated that 600 million gallons of water could be conserved by the year 2035.

- Get more information on 0.5 GPM faucet aerators here - http://allianceforwaterefficiency.org/Faucet_Fixtures_Introduction.aspx

Leak Detection

There in no one easy method to detect leaks in residential properties. A comprehensive approach must be used to detect leaks from all of the household's appliances, fixtures, or fittings. Several options are available: (1) Detect leaks using the existing water meter; (2) Use utility meter reading infrastructure to detect and report leaks remotely; (3) Install a leak detection system in the home.

Detect Leaks Using the Existing Water Meter

Larger leaks or a combination of small leaks can often be detected by carefully monitoring the water meter. A whole house meter check can sometimes identify a leak and its flow rate, but does not usually indicate where the leak is occurring. Performing this leak check includes the following procedures:

1. All water is turned off inside and outside the home. Special notice must be given to occupants to not use any water (including toilet flushing) for the next 20 minutes. This test must be performed when no automatic water equipment is used, such as irrigation controllers, clothes washers, dishwashers, etc. Occupants should also avoid using ice from refrigerator ice and water dispensers.
2. Record the reading of the water meter, and wait 15 minutes. Be certain no one uses any water during this time.
3. Record the reading of the meter again. If the meter has recorded water use during the test, it might be due to a leak. Verify that the water use is not due to small appliances such as water filters, water softeners, or whole house humidifiers. Perform test again, if necessary,
4. You can calculate monthly water waste from leaks by multiplying the water usage in the "15 minute" test period times 2,880. Remember to verify the units measured by the meter; some meters record usage in gallons, and some record usage in cubic feet. (There are 7.48 gallons per cubic foot)

Meter sensitivity varies greatly among meter makes and models. Even the age of the meter will affect its ability to detect small leaks in the home; meters become less sensitive as they age. The meter test only verifies large leaks; it cannot assure small leaks do not exist within the home. Even when leaks are detected, this test does not indicate the location of the leaks.

Use Utility Meter Reading Infrastructure to Detect and Report Leaks Remotely

EMWD is developing the capability to essentially perform the same type of leak test described above remotely using its advanced metering infrastructure (AMI). This technology enables EMWD to interrogate customer water meters more frequently – such as once a day or once per hour. Hourly readings can identify constant flows that occur all night or at times when no one is home. These flows could be caused by leaking fixtures or appliances. Once identified by the AMI system, EMWD can contact the customer via text message or email and alert them to the possibility of a leak. EMWD is developing these capabilities and hopes to be able to deploy such a system in the coming years.

Install a Leak Detection System

Several home leak detection systems are available on the market today. These systems typically include a special water meter that is installed after the utility meter and a control module with and LCD display that can be mounted inside the home. Once installed and configured, the leak detection system constantly monitors flow through the water meter. If constant flow is detected the system can signal an alarm, automatically shut of water to the home, or both. Systems typically feature an "Away from Home" setting that programs the system to shut off water if a leak is detected while the residents are away from home. These systems may be desirable for homes with a history of leakage or where valuables are present in the home that could be easily damaged if a major household leak were to occur while the residents were not at home.

Outdoor Guidelines

Indoor water use largely takes place while we are present and aware that it's happening. Outdoor use is far less intuitive and is often controlled by automatic timers that operate when no one is present. Furthermore, the entire procedure for determining the irrigation application is full of vague and indirect terminology. For example, irrigation demands are often expressed in terms of *inches* of required water, but irrigation timers normally require inputs in terms of *minutes of run time.* Water budgets and water bills are based on volumes of use (hundreds of cubic feet or billing units). The customer, meanwhile, is expected to calculate the correct amount of water to apply to a given landscape, and then know how to track the water use on the site to ensure that the actual application meets the appropriate irrigation requirement for the landscape. This is a challenge to say the least!

Outdoor Guideline Goals

This guidebook is designed to take the mystery out of determining the actual amount of water required by a landscape (known as the theoretical irrigation requirement, or TIR) and to provide simple tools for managing water use to ensure water efficiency is being achieved. These tools can help you stay on target with your irrigation application and provide references to key documents that will assist in the effort. The Eastern Municipal Water District provides a web-based tool for estimating the monthly outdoor water budget (http://www.emwd.org/index.aspx?page=291). This provides monthly water budgets for a given area based on a 70% conservation factor, but the web tool does not tell you how to create a landscape that can live on this budget, or track your use over an irrigation season, which is one of the main goals of this guidebook.

This guidebook includes a spreadsheet tool called the Eastern MWD Landscape Budget Worksheet (ELBW), which can be downloaded at www.emwd.org/landscapewaterbudget. The ELBW will allow you to determine the water requirements of virtually any landscape, to compare this to a target water budget, and to track the irrigation use over the year to compare actual use to budgeted use. The guidebook contains illustrations from the ELBW which show how it is used. In addition, the ELBW contains instructions on its use.

The guidebook focuses on water management and not on landscape design. There are many excellent sources of plant material and planting guides available and there are many local designers who can assist with this aspect of your landscape. This section of the guidebook focuses on providing the information on water use of landscapes.

This section of the *Water Efficient Guidelines for New Development* covers:

- Regulations governing landscapes in EMWD
- How to determine the water requirements of your landscape
- Tailoring your landscape to a specific water budget
- A review of water-wise landscape practices
- How to track water use to ensure compliance with the EMWD water budget rate structure

Landscape Regulations in EMWD

In the Eastern Municipal Water District service area there are three sets of outdoor water use regulations to consider:

1. The Water Budget Rate Structure of EMWD, which sets the maximum water budget for new landscapes at 70% of ET_o. The rate structure applies to all of EMWD new residential and landscape only customers, and provides a strong economic incentive to stay within the water budget[9].
2. The California Model Efficient Landscape Ordinance (MELO), which sets out detailed requirements for planning, design, and installation of new or renovated landscapes.
3. The California Green Building Standards Code (CALGreen), which sets out some voluntary (or mandatory depending on the locality) goals for additional water savings in new construction.

For practical purposes the MELO is the governing document for new and rehabilitated landscapes in the EMWD service area, as all of the communities in the area that have adopted it, or an equivalent ordinance, into their regulations. The MELO complies with the EMWD water budget rate structure in that both regulations are based on a maximum applied water allowance (MAWA) of no more than 70% of ET_o. The CALGreen standards however go beyond MELO using the concept of lower water allowances, and in suggesting the use of dedicated landscape water meters. The EMWD encourages new and rehabilitated landscapes to go beyond the 70% requirements and to consider landscapes at 60% or even 50% of ET_o.

When planning a new landscape, the first thing to determine is whether or not the provisions of the MELO apply to the project. If they do then it will be necessary to obtain specified permits and provide all of the documentation required by the MELO. A copy of the California Model Efficient Landscape Ordinance is available from the California Department of Water Resources website.[10]

According to the MELO, section 490.1, the following types of landscapes fall under the purview of the ordinance:

- New or redeveloped landscapes that are part of public or private projects having an area of 2500 square feet (SF), and that require a permit, plan check or design review by the local government.
- New or redeveloped landscapes in residential developments that are installed by developers, greater than 2500 SF in size requiring a permit, plan check or design review.
- New residential landscape installed by or contracted by homeowners with a total area greater than 5000 sf and requiring a permit, plan check or design review.

Those planning a new landscape in the EMWD service area must first determine if the project falls under the purview of MELO. If it does, consult with the local government regarding permit requirements and

[9] http://www.emwd.org/index.aspx?page=291

[10] http://www.water.ca.gov/wateruseefficiency/docs/MWELO09-10-09.pdf

obtain a copy of the ordinance from the website link provided above. If the project does not fall under purview of MELO, the rest of this guidebook can be used to determine the anticipated water requirements, water allowance, and monthly water budget.

Determining the Landscape Water Budget and Theoretical Irrigation Requirements

In the EMWD system there are two aspects for managing landscape water use. First, it is necessary to determine the water budget for each irrigated parcel using a formula prescribed by the District, and second, it is necessary to design a landscape that has a theoretical irrigation requirement that matches the water budget. This section of the guidebook explains how to accomplish both of these tasks. The landscape water budget is determined by means of a simple calculation. Determination of the theoretical irrigation requirement involves a trial-and-error procedure where areas and plant types are varied until the desired water requirement is obtained. The calculations presented in this guidebook are compatible with those contained in the MELO, but are presented in more convenient tabular form.

Water Budget Calculations

Determining the water budget for a given parcel of irrigated land involves just two variables: the irrigated area and the conservation factor. This simple calculation is based on the formula shown below:[11]

Water Budget = ET_o * CF * LA

Where:

- ET_o = Sum of observed ET_o values for the year, in feet (FT), which, for EMWD service area is 4.78 feet on average.
- CF = Conservation factor (0.6 or less)
- LA = Landscape area in square feet (SF)
- Water Budget = Water allocation for landscape in cubic feet (CF)

Definitions of all terms used in this guidebook are presented in the Glossary at the back.

The average annual ET_o in the EMWD service area is approximately 4.78 feet (57.33"). It is possible to produce a good estimate of an annual water allocation by multiplying the total landscape area (LA) of your site in square feet x 4.78 ft x CF = Water Budget (in cubic feet). The maximum allowable conservation factor for new or renovated landscapes in the EMWD is 0.60.

The conservation factor for new landscapes must be no greater than 60% of ET_o, but it can be lower. This is how additional outdoor water savings can be accomplished. As shown in this guidebook, it is possible to design beautiful landscapes that require 60% of ET_o without sacrifice.

[11] See http://www.emwd.org/index.aspx?page=310#33

Determining the Theoretical Irrigation Requirement for a Landscape

Once you know how much water you have to work with, the next step is to design a landscape that can thrive on this amount of water based on its theoretical irrigation requirement (TIR). The amount of water required by an irrigated area containing plants with similar water needs (i.e. a hydrozone) is a function of five variables: (1) the area of the hydrozone, (2) the water requirement of the plants it contains, (3) the density (or spacing) of the planting, (4) the microclimate (sun and wind exposure for example) of the area, and (5) the efficiency of the irrigation system. The water requirement of an entire landscape is simply the sum of the water requirements for the individual hydrozones. The basic equation is:

Theoretical Irrigation Requirement = (ET_o * Area * K_c * K_d * K_m)/Irrigated Zone Efficiency)

In order to simplify the process we have assumed typical values for the density, micro-climate, and irrigation efficiency of the hydrozones based on the types of plants they contain. This leaves only two variables to input: the area of the zone and the plant type. For example, typical turf areas will have a density factor of 1.0 and an irrigation efficiency of approximately 71% assuming a well-designed spray system and a full-sun micro-climate. The calculations in the TIR Calculation Table use these factors when cool season turf is selected from the Plant Type drop-down list. In addition the irrigated area, inserted by the user, and the local ET_o determine the TIR of each zone.

Table 4: Sample calculation of TIR for 600 SF of irrigated area and annual ET_o of 4.78 FT

TIR Calculation Table			
Zone	Irrigated Area	Plant Type	Theoretical Irrigation Requirement (TIR)
	(SF)	K_c	(CF/YR)
1	100	Pool/Spa/Pond	597
2	100	Cool season grass	538
3	100	Warm season grass	437
4	100	Moderate water use plants	255
5	100	Low water use plants	104
6	100	Very low water use plants	32
Σ Area =	600	CF	1,963
		BU	19.63

Table 4 shows a sample calculation from the ELBW of the theoretical irrigation requirement for six hypothetical hydrozones. Each zone is 100 square feet and has an annual ET_o of 4.78 feet. This table is an example from the ELBW, and shows how the theoretical irrigation requirement for each zone in the landscape and for the entire landscape is calculated. It's important to spend a little time understanding how this table works and its importance as a tool for calculating the water requirement for your landscape. A detailed explanation of Table 4 is presented in the paragraphs below.

The following sections explain each of the columns in Table 4. For more information on classification of plants by water use see the Water Use Classification of Landscape Species (WUCOLS)[12] or visit the Inland Empire Garden Friendly website[13].

Zone

The first column in Table 4 is the irrigation zone number. Each zone should contain plants with the similar watering requirement and the irrigation should be the same type throughout the zone, in other words all spray heads, rotors, or drip.

Irrigated Area

The second column in Table 4 is the irrigated area (SF) obtained from a plan or field measurement. Each zone has been set to 100 SF for this example.

Plant Types and Species Factor

Plant types can be divided by their water requirements, where the species factor (K_c) is the fraction of the amount of water a specific plant type needs in relation to a reference crop. Typically the reference crop is cool season grass mowed to 6" in height, in full sun, with an unlimited water supply. The species factor is obtained from resources such as the WUCOLS. Typical species factors for the range of plant types commonly used in the landscape are shown in Table 5. For specific guidance on the plant species that fall into each category of water use you should consult a reference such as the WUCOLS. Note that swimming pools are included in the list and given a K_c of 1.0.

Table 5: Typical plant types and species factors used in ELBW

Plant Code	Plant Type		K_c
0	Unplanted	UP	0
1	Cool season grass	CSG	0.8
2	Warm season grass	WSG	0.65
3	Pool/Spa/Pond	WATER	1
4	Moderate water use plants	MWUP	0.6
5	Low water use plants	LWUP	0.3
6	Very low water use plants	VLWUP	0.1

12 http://www.water.ca.gov/pubs/planning/guide_to_estimating_irrigation_water_needs_of_landscape_plantings_in_ca/wucols.pdf

13 www.iegardenfriendly.com

Theoretical Irrigation Requirement

The fourth column in Table 4 is the theoretical irrigation requirement needed annually in each of the six zones. The TIR ranges from a low of 32 CF annually for very low water use plants to a high of 597 CF for a pool. The total annual requirement for this 600 SF example landscape is 1,963 CF or 19.6 BU.

Additional Factors

There are three additional factors used to modify the irrigation requirement. Although you will not need to use these factors in calculating the TIR for your landscape (they have been calculated for you) it is good to have a basic understanding of

Density factor – K_d

The density factor, K_d, is determined by the number of plants in an irrigation zone and by the leaf area of the plants. Typical K_d ranges from 0.5 to 1.3. A newly planted landscape with immature plants has a K_d of 0.5, a healthy turf lawn has a K_d of 1.0 and an area with a mixture of dense vegetation that includes groundcover, shrubs, and trees might have a K_d of 1.2. As the landscape matures it becomes denser and the K_d is higher. Even when mature, a low water use landscape will have fewer plants that are widely spaced then a moderate water use landscape.

Microclimate factor – K_m

The microclimate factor, K_m, is simply the climate that affects a landscape on a zone by zone level and ranges from 0.5 to 1.4. A zone located on the east side of the house, protected from the wind, might have a K_m of 0.5 whereas a zone located on the windy, south side of the landscape, where heat is reflected off the side of the house might have a K_m of 1.4.

Zone Efficiency

Unfortunately irrigation systems are not 100% efficient; some of the water evaporates, some of it runs off, and some of it may not get to the plant that needs it the most. Some extra water is required to account for the fact that irrigation systems are not perfectly efficient. To prevent wasteful irrigation practices in determining water budgets the MELO has required that minimum efficiencies be used for design purposes. For spray zones this is 71% and for drip zones it is 90%

To prevent wasteful irrigation practices, EMWD has determined minimum *irrigation efficiency: Spray and rotor zones, typically used to irrigate turf must achieve an efficiency of 71% while drip irrigation zones much achieve an efficiency of 90%.*

Landscape Ratio

Once the theoretical irrigation requirement is determined the last step in the design process is to verify that the ratio of the TIR to the Reference (REF) requirement is equal or less than the conservation factor (CF). This is done by comparing the Landscape Ratio (R_L) to the Target Conservation Factor. If the Landscape Ratio is less than the Target Conservation Factor the landscape meets the water budget goal. As shown in Table 6 the example landscape from Table 4 has a landscape ratio of 60%.

Table 6: Landscape ratio comparison

Landscape Ratio (TIR/REF)			
ET Application Rate	ET_o	FT	4.78
Irrigated Area	A_i	SF	600
Reference Water Requirement	REF	CF	2,826
Theoretical Irrigation Requirement	TIR	CF	1,707
Target Conservation Factor	Fc	%	60%
Landscape Ratio (TIR/REF)	R_L		**60%**

Sample Landscape 1 with warm season grass and swimming pool – 60% of ET_o

Table 7 presents Sample Landscape 1, which is targeted to use 60% of the ET_o water requirement. In this example, the 3,500 SF landscape has seven irrigation zones. Zone 1 is 800 SF of warm season grass; Zone 2 is 700 SF of very low water use plants; Zone 3 is 475 SF of moderate water use plants; Zone 4 is 700 SF of low water use plants; Zone 5 is a 675 SF swimming pool; Zones 6 and 7 are each 75 SF of moderate water use plants.

Even though Zones 2 and 4 are each 700 square feet it's easy to see that Zone 4 (low water use plants) requires considerably more water than Zone 2 (very low water use plants). In fact it requires a little more than three times as much water or 725 CF/year (5,423 gallons/year). Even more dramatic however is the amount of water required by the swimming pool. Despite the fact that the pool is slightly smaller in area than either Zone 2 or Zone 4 (675 SF) it uses 4,031 CF/year (30,152 gallons/year). It's clear to see that by making relatively small changes in the landscape it is possible to make big savings in water.

Despite its high water use, the pool is included in this example design because many people consider a pool an essential component to the Southern California lifestyle. We want to demonstrate that it is possible to design a landscape that meets even aggressive conservation goals without sacrificing this amenity. If a pool is not part of your landscape you can include more turf or other plantings.

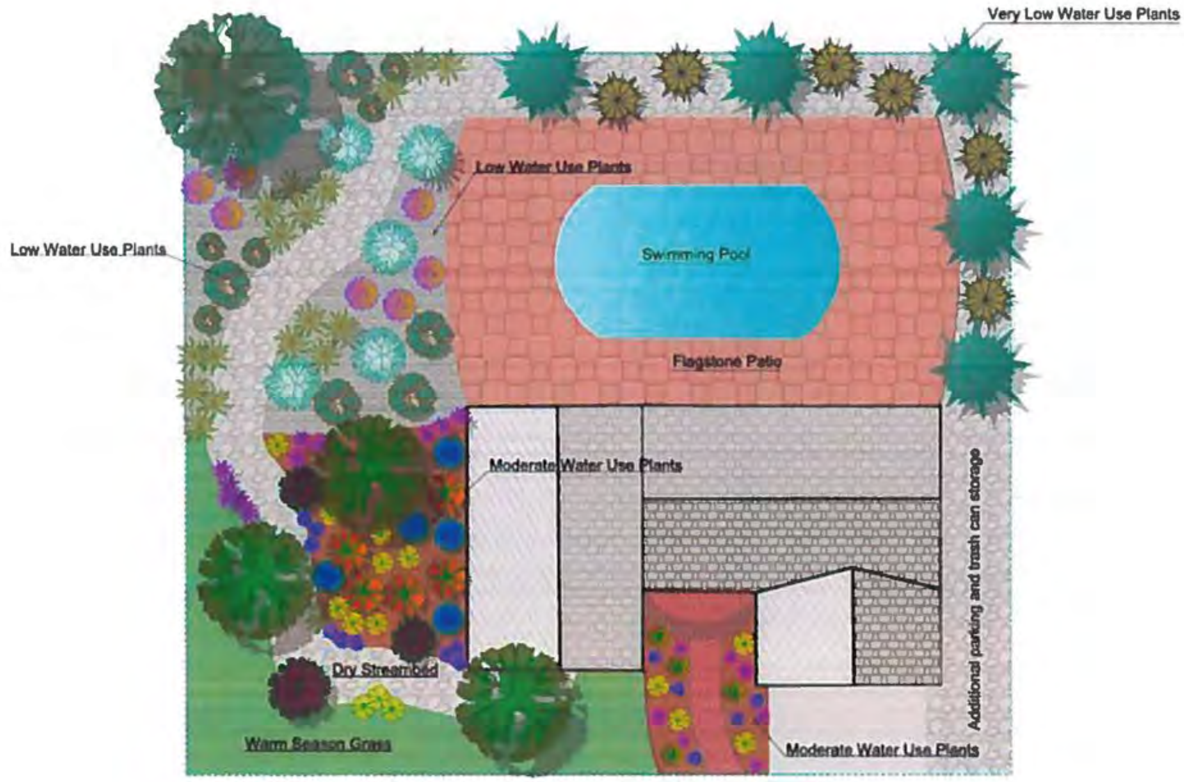


Figure 1: Example landscape with warm season grass and swimming pool

Table 7: Theoretical landscape requirement for a 3,500 SF landscape with a 60% conservation factor

TIR Calculation Table			
Zone	Irrigated Area	Plant Type	Theoretical Irrigation Requirement (TIR)
	(SF)		(CF/YR)
1	800	Warm season grass	3,499
2	700	Very low water use plants	223
3	475	Moderate water use plants	1,210
4	700	Low water use plants	725
5	675	Pool/Spa/Pond	4,031
6	75	Moderate water use plants	191
7	75	Moderate water use plants	191
Σ Area =	3,500	CF	10,070
		BU	100.70

Table 8 summarizes the water requirements for the 60% of ET sample landscape. This 3,500 SF landscape will require 10,101 CF (101 BU) of irrigation over the course of a year, which is 60% of the reference requirement. Since the actual landscape ratio equals the target conservation factor the landscape meets the requirements of the budget.

Table 8: Summary table for 3,500 SF landscape with a 60% conservation factor

Water Use Summary for Design			
ETo Application Rate	ETo	FT	4.78
Irrigated Area	A_I	SF	3,500
Reference Water Requirement	REF	CF	16,721
Theoretical Irrigation Requirement	TIR	CF	10,101
Target Conservation Factor	CF	%	60%
Landscape Ratio (TIR/REF)	R_L	%	60%

Note: The Landscape Ratio (R_L) must not exceed Target Conservation Factor in order to comply with the water budget.

Sample Landscape 2 with cool season turf and no pool – 60% of ET_o

Sample Landscape 2, shown in Table 9, also has a conservation factor of 60%. Several modifications to the design help achieve this water efficiency goal. The total landscape area is still 3,500 SF but there is no swimming pool. Because some HOA's require grass in the front yard this design includes 850 SF of cool season grass. The design also includes 1,650 SF of moderate water use plants around the flagstone patio and two small zones of moderate water use plants adjacent to the front walkway. While the water requirement of the turf and moderate water use plants is fairly high it is possible to include them in the landscape by off-setting their water demand with 850 SF of low water use plants. Example 2 shows that achieving a landscape ratio of 0.60 can be done quite easily.

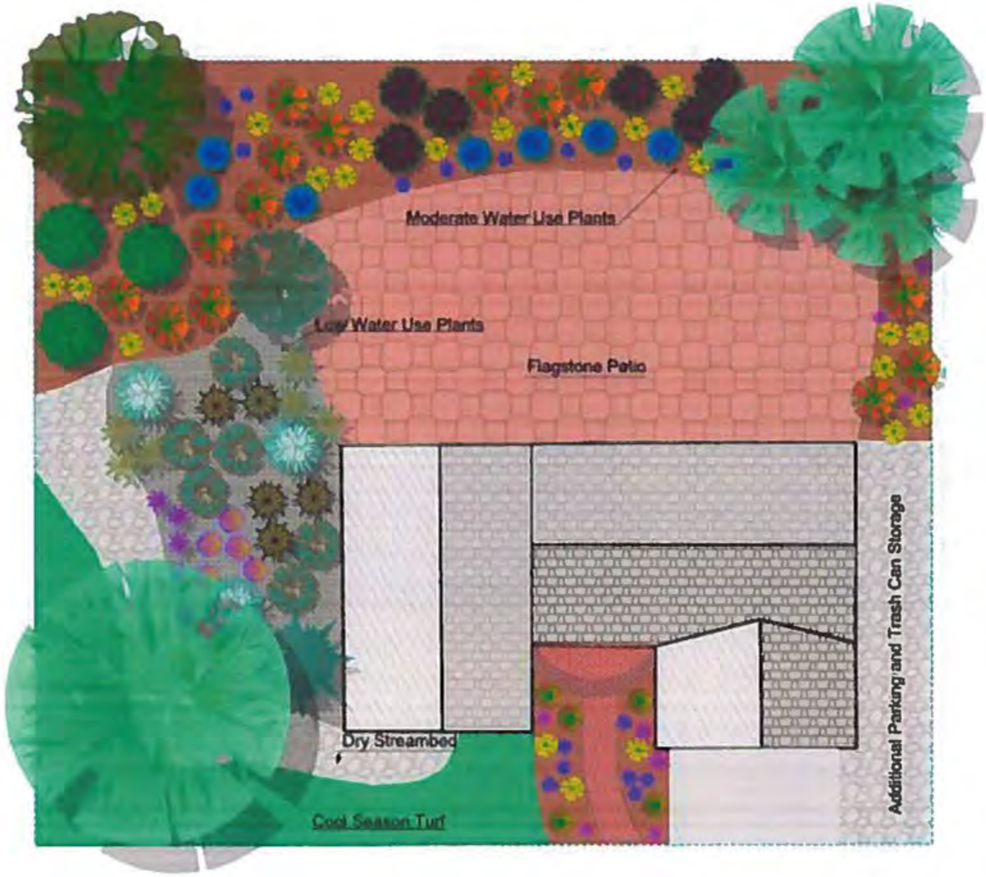


Figure 2: Example landscape with cool season turf and no pool

Table 9: Theoretical landscape requirement for a 3,500 SF landscape with a 60% conservation factor

TIR Calculation Table			
Zone	Irrigated Area	Plant Type	Theoretical Irrigation Requirement (TIR)
	(SF)		(CF/YR)
1	1650	Moderate water use plants	4,204
2	850	Low water use plants	880
3	850	Cool season grass	4,576
4	75	Moderate water use plants	191
5	75	Moderate water use plants	191
Σ Area =	3,500	CF	10,042
		BU	100.42

This landscape achieves a ratio of 0.60 which matches the target of a landscape with a conservation factor of 60%. This 3,500 SF landscape will require 10,042 CF (10.04 BU) of irrigation over the course of a year, which is 60% of the reference requirement. Since the actual landscape ratio equals the target conservation factor the landscape meets the requirements of the budget.

Table 10: Summary table for 3,500 SF landscape with a 60% conservation factor

Landscape Ratio (TIR/REF)			
ET Application Rate	ET_o	FT	4.78
Irrigated Area	A_i	SF	3,500
Reference Water Requirement	REF	CF	16,721
Theoretical Irrigation Requirement	TIR	CF	10,042
Target Conservation Factor	Fc	%	60%
Landscape Ratio (TIR/REF)	R_L		**60%**

Note: The Landscape Ratio (R_L) must not exceed Target Conservation Factor in order to comply with the water budget.

Sample Landscape 3 – 60% of ET_o

Sample Landscape 3, shown in Table 11, is 3,500 SF of various plant types. Zone 1 consists of 1,925 SF of warm season grass; Zone 2 is 1,125 SF of low water use plants, Zone 3 is 300 SF of very low water use plants and Zones 4 and 5 are each 75 SF of moderate water use plants. In this example, there is a fairly large area of warm season grass which has a high water demand of 8,420 CF/year. This demand has been offset by several areas of low and very low water use plants to meet the conservation factor of 60%.

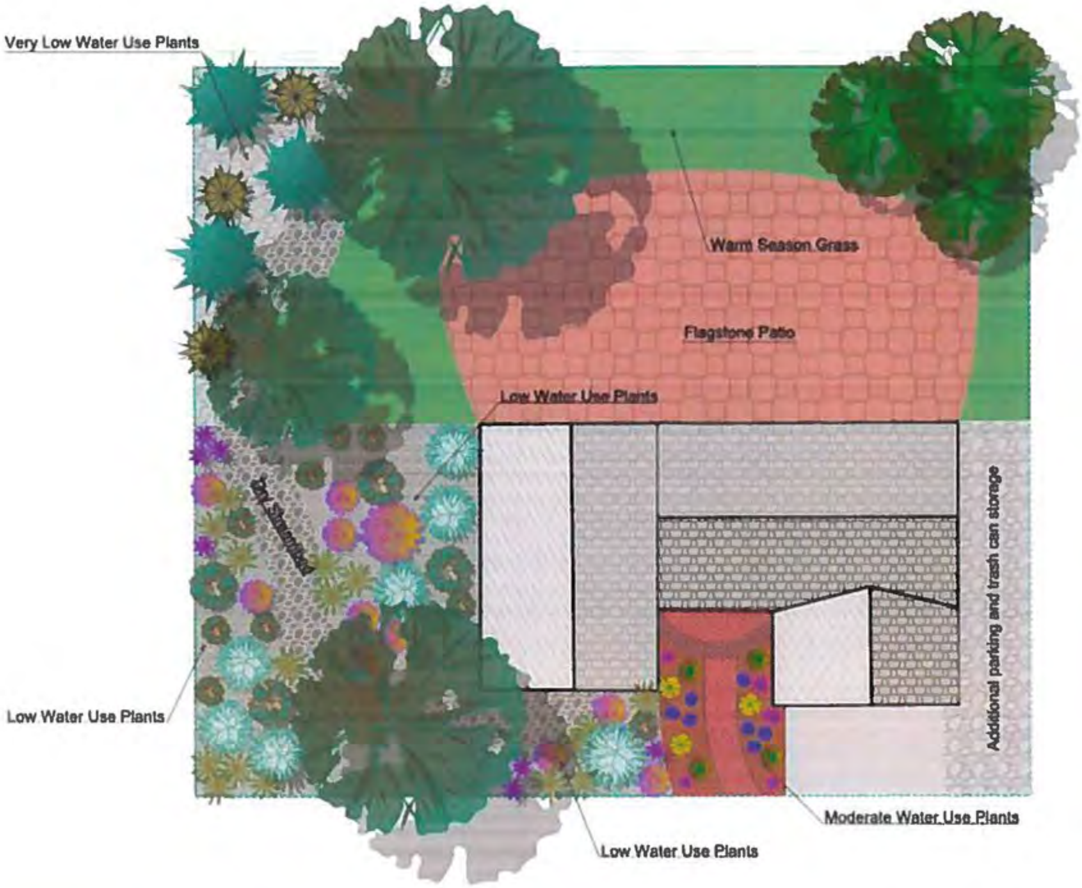


Figure 3: Example landscape at CF=60%

Table 11: Theoretical landscape requirement for a 3,500 SF landscape with a 60% conservation factor

TIR Calculation Table			
Zone	**Irrigated Area**	**Plant Type**	**Theoretical Irrigation Requirement (TIR)**
	(SF)		(CF/YR)
1	1925	Warm season grass	8,420
2	1125	Low water use plants	1,165
3	300	Very low water use plants	96
4	75	Moderate water use plants	191
5	75	Moderate water use plants	191
Σ Area =	**3,500**	**CF**	**10,062**
		BU	**100.62**

Table 12 summarizes the water requirements for the 60% of ET_o sample landscape. This 3,500 SF landscape will require 10,062 CF (101 BU) of irrigation over the course of a year, which is 60% of the reference requirement. Since the actual landscape ratio equals the target conservation factor the landscape meets the requirements of the budget.

Table 12: Summary table for 3,500 SF landscape with a 60% conservation factor

Water Use Summary for Design			
ETo Application Rate	ETo	FT	4.78
Irrigated Area	A_i	SF	3,500
Reference Water Requirement	REF	CF	16,721
Theoretical Irrigation Requirement	TIR	CF	10,062
Target Conservation Factor	CF	%	60%
Landscape Ratio (TIR/REF)	R_L	%	60%

Note: The Landscape Ratio (R_L) must not exceed Target Conservation Factor in order to comply with the water budget.

The Seven Principles of Water Conserving Landscapes

The seven fundamental principles of a water conserving landscape are:

1. Create a landscape plan
2. Prepare the soil
3. Create practical turf areas
4. Group plants into appropriate hydrozones
5. Irrigate efficiently
6. Mulch
7. Proper maintenance

*Looking for garden friendly plants for your Inland Empire home? Visit **www.iegardenfriendly.com** for 100's of options. A partial list of garden friendly plants is included in Appendix A.*

Following are some tools to help use the seven principles of water conserving landscapes to create new landscapes that are capable of thriving on less water than traditional turf landscapes.

1. Create a Landscape Plan

Planning the landscape is the first and one of the most important steps in creating a waterwise landscape. Waterwise landscaping should enhance the beauty of the home and provide outdoor spaces to play and relax. After all, if water savings were the only goal, a yard covered in rock or concrete would be more effective!

A blank landscape canvas can be a bit intimidating. Walk around the property and sketch the layout of the house, fence line, pool, deck, trees and other permanent items. Take into consideration the planting area and the ultimate size of the plants in the landscape. Notice the compass orientation of the landscape. Are there shady areas? Are there areas that receive full sun most of the day? Are there low-lying areas that stay moist after a rainstorm? Start by determining the most important elements of the landscape and plant around them. Will there be a deck or patio for entertaining? Will there be a kid's play area? Is there a view that you want to preserve or an eyesore to hide from view? Would a well-placed tree provide shade and cooling for the patio? The answers to these questions can be part of planning a water-wise landscape.

2. Prepare the Soil

Soil is the foundation of any landscape. Soil is the medium through which plants are supplied with nutrients and water. Roots are unable to penetrate soil that is heavily compacted and water drains too quickly through poor, sandy, soil. Soil provides the mechanical support for plants by allowing the roots to grow deeper and wider. Soil improvement can change the physical structure of the soil, the chemistry of the soil, or both. There are many soil amendments available although the most common are compost, manure and peat most. Even shredded newspaper, mixed with compost, can improve soil texture and nutrients to the soil. This is a place where it makes sense not to scrimp. Poor quality soil amendments can be high in salts and full of weed seeds.

An unfortunate practice in some new development is to remove the top soil from the site and sell it. In addition, soil is often badly compacted by heavy equipment leaving most sites unsuitable for planting. Soil can be too sandy or too clayey. Clay soil often has a build-up of salts and sandy soil is often nutrient poor. The ideal time to improve the soil is prior to the installation of the irrigation system and plants. Plants do best when organic material is worked evenly through the entire planting bed.

3. Create Practical Turf Areas

Thick, green, lawns have long been a mainstay of American landscapes, a holdover from English cottage gardens that were associated with an "ideal landscape." In recent years lawns have developed a reputation for being the most water thirsty plant in the landscape and programs have sprung up to eliminate lawns. However, with a well-planned and well-designed landscape it is possible to maintain some turf areas and still be water efficient.

Spend a little time thinking about how much and where turf is needed (if at all). Nothing stands up to the rigors of hard play, pets, and kids than a thick stand of turf. If there is a park nearby, a turf area may be less essential. There are many beautiful groundcovers that require less water than turf and require no mowing.

Many traditional landscapes consist of turf areas bordered by sidewalks, driveways, and other hardscape. These areas are irregularly shaped which is aesthetically pleasing from a design stand point but notoriously difficult to water efficiently. Everyone has seen water running down the street from overspray on a driveway or sidewalk in an attempt to irrigate a narrow strip of grass. If turf is to be part of the new landscape, think carefully about the proper location and size. It is much more efficient to irrigate one large area of turf than several small areas. The most efficient shape to irrigate is a square or large rectangle. Sprinkler nozzles are designed to irrigate in straight, overlapping patterns, which makes tight curves and circles difficult to irrigate efficiently. Because curves are aesthetically more pleasing to the eye try to create long, gently curved lines. Eliminate all but the most essential turf from the landscape. Eliminate turf under trees and large shrubs. Their water needs are different from turf and if a reduction in turf irrigation is required during times of drought it increases that chance of killing the trees and shrubs as well.

4. Appropriate Plant Material and Hydrozones

Imagine that you and your friends are trying to decide where to go on vacation. Your idea of the ideal vacation spot is soaking up the sun on a tropical beach. Another friend would prefer hiking in the cool, shade of some big trees, while a third friend loves the hot, dry desert sun during the day with cool gentle breezes at night. Chances are good none of you are going to be happy vacationing in the same place. The same is true of the plants in your landscape. While all plants need food, light, and water to survive providing too much or too little of any of those things can result in stressed plants and a poor quality landscape.

Selecting the right plants, for the right area in your landscape will result in happy, healthy plants that will thrive and beautify your landscape for many years to come. Healthy plants require less maintenance, less water, and less pest control – in other words they require less work. Fortunately, due to the interest in native and low-water use plants there is a wealth of information available to help you select the right plants for your landscape.

With new plant species and varieties becoming available every year the choices available for the waterwise garden is limited only by our imagination. Plants come in an endless array of colors, sizes, and textures to suit a wide range of gardening styles. Thanks to nearly thirty years of research and experimentation waterwise gardeners are no longer limited to prickly cacti and lots of rock. Visit nurseries, walk around neighborhoods, and look through gardening books, particularly if they were written for your region. Perhaps the serenity of a silver, gray, and white garden appeals to you. Maybe a riot of color is just what you need to energize you for the day. Find your style and create your landscape.

After living with a landscape for a number of years you become familiar with the plants that are thriving and the plants that seem to be struggling. With the exception of large trees and shrubs almost any plant can be relocated. Remove and replace plants that aren't thriving or require a lot of water.

5. Irrigation

Just a brief drive in undeveloped areas reveals what our landscape would look like without supplemental irrigation. Irrigation allows us to grow plants that would otherwise perish in a natural setting.

The ideal irrigation system should deliver the right amount of water, where it's needed, and only when it is needed. An irrigation system capable of doing that would be considered 100% efficient. Unfortunately many irrigation systems are far from ideal. Residential irrigation system audits have revealed irrigation efficiencies as low as 30%. One goal of a waterwise landscape is to reduce or eliminate wasteful irrigation and increase the efficiency of the system. While no system will be 100% efficient there are many things you can do to improve the efficiency of your system.

Once you have your landscape design, you can decide how to irrigate the landscape and design the system. Many people manually irrigate their landscapes with hoses and sprinklers. Manual irrigation is less expensive and uses less water in most cases. This is almost always the most efficient way to irrigate a landscape. If an automatic system is installed, overhead spray irrigation is the least efficient irrigation type; drip irrigation is the most efficient. Turf areas can be irrigated with spray or subsurface drip. The rest of the landscape can usually be irrigated with drip and micro-spray. Drip irrigation is not only more efficient, it's also more flexible than spray irrigation. It can move and expand as the landscape matures.

Standard irrigation controllers typically irrigate on a set, day-of-the-week schedule and each zone runs for a set number of minutes. Changing the schedule requires input from the homeowner or landscape contractor. Homeowners often "set it and leave it" which can result in a considerable amount of over-irrigation.

Irrigation technology is now available that takes the much of the guesswork out of irrigation scheduling. Weather-based irrigation controllers (WBICs), also known as "smart controllers", use local weather data, either historic or real-time, to adjust the amount of irrigation supplied to the landscape. WBICs respond to factors such as temperature, humidity, and solar radiation and make adjustments to the irrigation schedule accordingly. Because of their potential for reducing over-watering, rebates are available for some models of WBICs. More information on WBICs can be found on the SoCAL Water $mart website[14].

Sprinkler systems consist of moving parts and like any other mechanical device they can wear out. Exposure to lawn mowers, heat and cold, and dirt all cause parts to malfunction and effect the operation of the system. Regular maintenance is required.

6. Mulching

Mulch serves to unify the appearance of landscape, retain soil moisture, reduce soil temperatures, control erosion from wind and rain, and reduce weed growth. There are dozens of materials to choose from although availability may vary in different parts of the country or even regionally. The least expensive mulch are materials such as newspaper, dried grass clippings, leaves, and straw but these are generally considered the least attractive as well. Bark chunks, shredded cedar, pine needles, nut shells, are more expensive but serve to add to the aesthetics of the landscape. These organic mulches have the added benefit of decomposing over time and replacing nutrients in the soil. Organic mulches will need to be replenished periodically; those living in windy areas may need to replace their mulch annually.

Inorganic mulch such as river rock, crushed stone and decomposed granite typically have the highest upfront costs for both material and labor but are long-lasting. Many native and low water use plants actually prefer inorganic mulches for several reasons: they reflect heat and light back to the plant, they don't increase the nutrient content in the soil, and reduce the moisture around the base of the plant which can make waterwise plants prone to rotting.

7. Maintenance

Aside from the aesthetics, a well-planned waterwise landscape uses less water and requires less maintenance. If you followed the earlier steps in planning, planting, soil preparation, irrigation, and mulching your landscape you can significantly reduce the amount of maintenance.

If you've planned your landscape carefully your plants will fit nicely in the space you've provided and the only pruning they'll require is to shape them and remove diseased or broken branches. In fact, many waterwise plants tend to look better in a more natural state.

Many waterwise plants are accustomed to and prefer growing in lean soil (low in nitrogen, phosphorus, and potassium) so if you've done a good job of preparing your soil prior to planting many waterwise

[14] http://www.socalwatersmart.com/index.php/qualifyingproducts/wbics

plants will have all of the nutrients they need for many years to come without the need for additional fertilizer. In fact, too much fertilizer can result in a plant that grows or blooms itself literally to death.

Cool season turf grass is the one plant in the waterwise landscape that will need regular feeding in order to thrive. The rapid growth and frequent watering depletes the nutrients in the soil and must be replaced regularly. Grass clippings contain nitrogen and can replace some of the nutrients in the lawn if left in place after mowing. Irrigation, mowing, and other activities can result in soil compaction in turf areas. Twice annual aeration improves the porosity of the soil and makes water and nutrients more readily available to the plant.

For many homeowners weeding is perhaps the most dreaded of all gardening chores. Not only are weeds unwanted and unsightly but they compete with desirable plants for nutrients, water, and sunlight. While there is no way to completely eliminate weeds there are several gardening practices that will reduce their number. Make sure that soil amendments are weed free and eliminate as many weeds as possible before adding plants to a new planting bed. Be prepared to mulch flower beds as soon as they've been planted and replenish mulch on a regular basis. Provide only as much water as needed to keep desirable plants healthy and direct the water to the roots of the plants.

Pull weeds when they are small. Part of the reason that weeds do so well in the garden is that they have very extensive root systems. This is what makes them difficult to pull. And they like water as well as the next plant so they're likely to grow right next to the desirable plants. Removing a large weed may damage or weaken the roots of adjacent plants. Removing weeds when they're small also reduces the likelihood that they will go to seed and create more weeds in the garden.

Landscaping Do's and Don'ts

Do:

- Think long-term – remember that the landscape can be added to over a period of several years
- Experiment with color and new plants. The selection of available plants is nearly limitless.
- Create irrigation hydrozones
- Know the horticultural requirements of your plants (full sun, low water use, sandy soil) and plant them in the appropriate area of the landscape
- The ultimate size of the plant
- Adjust your irrigation schedule at least monthly and as your landscape matures
- Use mulch
- Maintain your xeriscape
- Plant turf where it serves a purpose. Some HOA's require the use of turf in the front yard but when possible use turf as a play area for pets and children.

Don't:

- Overplant or crowd plants. Remember that the tiny plant in the 4" pot may turn into an enormous plant in 5 - 10 years.

- Don't create a monoculture with rocks, gravel, mulch, or the same type of plant.
- Mix irrigation types or nozzles. Rotors, spray heads and drip irrigation apply water at different rates.
- Set your irrigation schedule and leave it. Unless you have a WBIC make a point of adjusting your irrigation schedule on a monthly basis.
- Mix plants with different cultural needs
- Allow weeds to take over. Not only are weeds unsightly, they compete with desirable plants for moisture and nutrients.
- Don't be afraid to use turf; use it appropriately and sparingly.

Appendix A – Examples of Some Inland Empire Garden Friendly Plant List (non-turf plants)

Scientific Name	Common Name	Sun Shade	Water Requirements	Type	Foliage	California Native	Link
Abelia floribunda	Mexican Abelia	P, F	M	Sh	E		http://plantlust.com/plants/abelia-floribunda/
Abelia x grandiflora	Glossy Abelia	P, F	M	Sh	E		http://plantlust.com/plants/abelia-x-grandiflora/
Acacia cultriformis	Knife Acacia	F	L	T	E		http://plantlust.com/search/#raw=Acacia+cultriformis
Acacia stenophylla	Shoestring Acacia	F	L	T	E		http://plantlust.com/search/#/raw=Acacia%20stenophylla http://www.monrovia.com/plant-catalog/plants/1214/shoestring-acacia.php
Anigozanthos flavidus	Kangaroo Paw	F	M	Ps	E		http://plantlust.com/search/#/raw=Anigozanthos
Arbutus unedo	Strawberry Tree	F	L	T	E		http://plantlust.com/search/#/raw=Arbutus%20unedo http://www.monrovia.com/search.php?query=Arbutus+unedo+&x=6&y=13
Arctotis acaulis	African Daisy	F	L	Ps	E		http://plantlust.com/search/#/raw=Arctotis%20acaulis;
Buddleia davidii	Butterfly Bush	F	M	Sh	E		http://plantlust.com/search/#/raw=Buddleia%20davidii http://www.monrovia.com/plant-catalog/plants/2996/english-butterfly-purple-emperor-butterfly-bush.php
Calliandra Eriophylla	Fairy Duster	F	VL	Sh	E		http://plantlust.com/plants/calliandra-eriophylla/ http://www.monrovia.com/plant-catalog/plants/812/pink-fairy-duster.php
Callistemon citrinus 'Little John'	Dwarf Bottlebrush	F	L	Sh, G	E		http://www.monrovia.com/plant-catalog/plants/418/dwarf-bottlebrush.php
Ceanothus griseus horizontails	Carmel Creeper	F	L	G	E	Yes	http://www.monrovia.com/plant-catalog/plants/1219/variegated-carmel-creeper.php

Scientific Name	Common Name	Sun Shade	Water Require ments	Type	Foliage	California Native	Link
Ceanothus thyrsiflorus 'Victoria'	Victoria California Lilac	F	L	Sh	E	Yes	http://plantlust.com/search/#/raw=Ceanothus%20thyrsiflorus%20%27Victoria%27 http://www.monrovia.com/plant-catalog/plants/707/victoria-california-lilac.php
Ceanothus x Dark Star	Dark Star California Lilac	F	L	Sh	E		http://plantlust.com/search/#/raw=Ceanothus%20x%20Dark%20Star http://www.monrovia.com/plant-catalog/plants/707/victoria-california-lilac.php
Cercis canadensis	Eastern Redbud	P, F	M	T	D		http://plantlust.com/search/#/raw=Cercis%20canadensis http://www.monrovia.com/plant-catalog/plants/2632/ace-of-hearts-redbud.php
Cercis occidentalis	Western Redbud	P, F	L	T	D	Yes	http://plantlust.com/search/#/raw=Cercis%20occidentalis
Cistus ladanifer	Crimson-Spot Rock Rose	F	L	Sh, G	E		http://plantlust.com/search/#/raw=Cistus%20ladanifer http://www.monrovia.com/search.php?query=Cistus+ladanifer&x=6&y=3
Cistus x hybridus	White Rock Rose	F	L	Sh, G	E		http://plantlust.com/search/#/raw=Cistus%20x%20hybridus
Cistus x purpureus	Purple Rock Rose	F	L	Sh, G	E		http://plantlust.com/search/#/raw=Cistus%20x%20purpureus http://www.monrovia.com/plant-catalog/plants/778/purple-rock-rose.php
Escallonia x	Escallonia	F	L, M	Sh	E		http://plantlust.com/search/#/raw=Escallonia%20x http://www.monrovia.com/plant-catalog/plants/1093/pink-princess-escallonia.php
Hemerocallis x 'Aquarius'	Aquarius Daylily	F	M	Ps	E		http://www.monrovia.com/plant-catalog/plants/1508/aquarius-daylily.php
Hemerocallis x 'Bonanza'	Bonanza Dwarf Daylily	F	M	Ps	E		http://www.monrovia.com/plant-catalog/plants/2419/bonanza-dwarf-daylily.php
Hemerocallis x 'Chicago Apache'	Chicago Apache Daylily	F	M	Ps	E		http://www.monrovia.com/plant-catalog/plants/2422/chicago-apache-daylily.php

Scientific Name	Common Name	Sun Shade	Water Requirements	Type	Foliage	California Native	Link
Hemerocallis x 'Children's Festival'	Children's Festival Daylily	F	M	Ps	E		http://www.monrovia.com/plant-catalog/plants/1395/childrens-festival-daylily.php
Heteromeles arbutifolia	Toyon	F	L	Sh	E	Yes	http://plantlust.com/search/#/raw=Heteromeles%20arbutifolia http://www.monrovia.com/plant-catalog/plants/111/brilliant-red-chokeberry.php
Iris douglasiana	Douglas Iris	F, P	M	Ps	E	Yes	http://plantlust.com/search/#/raw=Iris%20douglasiana
Kniphofia hirsuta 'Fire Dance'	Fire Dance Dwarf Poker	F	L	Ps	E		http://plantlust.com/search/#/raw=Kniphofia%20hirsuta%20%27Fire%20Dance%27 http://www.monrovia.com/plant-catalog/plants/2979/fire-dance-dwarf-poker.php
Kniphofia uvaria	Red Hot Poker	F	L	Ps	E		http://plantlust.com/search/#/raw=Kniphofia%20uvaria http://www.monrovia.com/plant-catalog/plants/1724/flamenco-red-hot-poker.php
Lagerstroemia indica	Crape Myrtle	F	L	T	D		http://plantlust.com/search/#/raw=Lagerstroemia%20indica http://www.monrovia.com/plant-catalog/plants/1735/centennial-spirit-crape-myrtle.php
Lantana camara	Bush Lantana	F	M	Sh, G			http://plantlust.com/search/#/raw=Lantana%20camara http://www.monrovia.com/search.php?query=Lantana+camara&x=4&y=16
Lantana montevidensis	Trailing Lantana	F	M	Sh, G			http://plantlust.com/search/#/raw=Lantana%20montevidensis http://www.monrovia.com/plant-catalog/plants/1754/chapel-hill-yellow-lantana.php
Lavandula angustifolia	English Lavendar	F	L	Ps	E		http://plantlust.com/search/#/raw=Lavandula%20angustifolia http://www.monrovia.com/plant-catalog/plants/1775/munstead-lavender.php
Lavandula	Spanish	F	L	Ps	E		http://plantlust.com/search/#/raw=Lavandula%20stoechas

Scientific Name	Common Name	Sun Shade	Water Require ments	Type	Foliage	California Native	Link
stoechas	Lavendar						http://www.monrovia.com/plant-catalog/plants/497/hazel-spanish-lavender.php
Leptospermum laevigatum	Austrailian Tea Tree	F	L	T	E		http://www.calflora.org/cgi-bin/species_query.cgi?where-calrecnum=4727
Leptospermum scoparium	New Zealand Tea Tree	F	L	T	E		http://plantlust.com/search/#/raw=Leptospermum%20scoparium http://www.monrovia.com/plant-catalog/plants/1783/dwarf-new-zealand-tea-tree.php
Leucophyllum frutescens	Texas ranger	F	M	Sh	E		http://plantlust.com/search/#/raw=Leucophyllum%20frutescens
Ligustrum japonicum	Wax Leaf Privet	F	M	Sh	E		http://plantlust.com/search/#/raw=Ligustrum%20japonicum http://www.monrovia.com/plant-catalog/plants/2480/curled-leaf-privet.php
Lobelia laxiflora	Mexican Bush Lobelia	F, P	VL	Ps	E		http://plantlust.com/plants/lobelia-laxiflora/ http://www.monrovia.com/plant-catalog/plants/3603/mexican-cardinal-flower.php
Lotus scoparius	Deerweed	F	VL	Ps	D		http://www.calflora.org/cgi-bin/species_query.cgi?where-calrecnum=5072
Muscari macrocarpum	Grape Hyancinth	S	VL	Ps	D		http://plantlust.com/plants/muscari-macrocarpum-waynes-clone/
Myoporum parvifolium	Creeping Myoporum	F	M	Sh, G	E		http://plantlust.com/search/#/raw=Myoporum%20parvifolium
Nandina domestica	Heavenly Bamboo	F, P	M	Sh, G	E		http://plantlust.com/search/#/raw=Nandina%20domestica http://www.monrovia.com/plant-catalog/plants/3445/emerald-sea-heavenly-bamboo.php
Nassella tenuissima	Texas Needle Grass	F	VL	P	P		http://www.monrovia.com/plant-catalog/plants/1150/mexican-feather-grass.php
Olea europaea	Olive Tree	F	L	T	E		http://plantlust.com/search/#/raw=Olea%20europaea

Scientific Name	Common Name	Sun Shade	Water Requirements	Type	Foliage	California Native	Link
							http://www.monrovia.com/plant-catalog/plants/3280/sevillano-fruiting-olive.php
Osteospermum pluvalis	African Daisy	F	L,M	Ps, G	E		http://www.monrovia.com/plant-catalog/plants/3487/lavender-mist-sun-daisy.php
Osteospermum sp Lavender	Lavender Mist Sun Daisy	F	L ,M	Ps, G	E		http://plantlust.com/search/#/raw=Osteospermum%20sp%20Lavender http://www.monrovia.com/search.php?query=Osteospermum+sp+Lavender&x=14&y=7
Parkinsonia aculeata	Palo Verde	F	L	T	E		http://plantlust.com/search/#/raw=Parkinsonia%20aculeata
Phormium tenax	New Zealand Flax	F	M	Sh	E		http://plantlust.com/search/#/raw=Phormium%20tenax http://www.monrovia.com/search.php?query=Phormium+tenax&x=8&y=13
Phyla nodiflora	Lippia	F	L, M	G	E		http://www.calflora.org/cgi-bin/species_query.cgi?where-taxon=Phyla+nodiflora
Pinus halepensis	Aleppo Pine	F	L	T	E		http://plantlust.com/search/#/raw=Pinus%20halepensis http://www.monrovia.com/plant-catalog/plants/836/blue-angel-white-pine.php
Pinus pinea	Italian Stone Pine	F	L	T	E		http://plantlust.com/search/#/raw=Pinus%20pinea
Pittosporum tenuifolium	Tawhiwhi	F	M	Sh	E		http://plantlust.com/search/#/raw=Pittosporum%20%20tenuifolium http://www.monrovia.com/plant-catalog/plants/464/marjorie-channon-kohuhu.php
Pittosporum tobira	Mock Orange	F	M	Sh	E		http://plantlust.com/search/#/raw=Pittosporum%20%20tobira http://www.monrovia.com/plant-catalog/plants/2428/japanese-mock-orange.php
Platanus racemosa	California Sycamore	F	M	T	D	Yes	http://plantlust.com/search/#/raw=Platanus%20racemosa
Prunus	Purple Leaf	F	M	T	D		http://plantlust.com/search/#/raw=Prunus%20cerasifera

Scientific Name	Common Name	Sun Shade	Water Require ments	Type	Foliage	California Native	Link
cerasifera	Plum						http://www.monrovia.com/plant-catalog/plants/2004/krauter-vesuvius-purple-leaf-plum.php
Prunus ilicifolia	Holly Leaf Cherry	F	VL	T, S	E		http://plantlust.com/plants/prunus-ilicifolia/;
Pyracantha x 'Monelf'	Red Elf Pyracantha	F	L	Ps	E		http://www.monrovia.com/plant-catalog/plants/2030/red-elf-pyracantha.php
Pyracantha x 'Ruby Mound'	Ruby Mound	F	M	Ps, G	E		http://www.ehow.com/how_4615849_plant-care-pyracanthas.html
Quercus agrifolia	Coast Live Oak	F	L	T	E	Yes	http://www.calflora.org/cgi-bin/species_query.cgi?where-calrecnum=6983
Quercus suber	Cork Oak	F	L	T	E		http://plantlust.com/search/#/raw=Quercus%20suber
Ranunculus californicus	California Buttercup	F	VL	Ps	D		http://plantlust.com/plants/ranunculus-californicus/
Rhaphiolepis indica	Indian Hawthorn	F	M	Sh	E		http://plantlust.com/plants/rhaphiolepis-indica/ http://www.monrovia.com/plant-catalog/plants/1967/eleanor-taber-indian-hawthorn.php
Rhus lancea	African Sumac	F	L	T	E		http://plantlust.com/search/#raw=Rhus+lancea
Rosa californica	California Wild Rose	P	L	Sh	D	Yes	http://plantlust.com/search/#/raw=Rosa%20californica
Rosmarinus officinalis	Rosemary	F	L	Sh, G	E		http://plantlust.com/search/#/raw=Rosmarinus%20officinalis http://www.monrovia.com/search.php?query=Rosmarinus+officinalis&x=3&y=14http://www.monrovia.com/search.php?query=Rosmarinus+officinalis&x=3&y=14
Salvia clevelandii	Cleveland Sage	F	L	Sh	E		http://plantlust.com/search/#/raw=Salvia%20clevelandii http://www.monrovia.com/search.php?query=Salvia+clevelandii&x=13&y=8
Salvia leucantha	Mexican Bush Sage	F	L	Sh	E		http://plantlust.com/search/#/raw=Salvia%20leucantha http://www.monrovia.com/plant-catalog/plants/2314/santa-barbara-mexican-bush-sage.php
Shepherdia	Silver	F	VL	Sh	E		http://plantlust.com/plants/shepherdia-argentea/

Scientific Name	Common Name	Sun Shade	Water Require ments	Type	Foliage	California Native	Link
argentea	Buffaloberry						
Trachelospermum jasminoides	Star Jasmine	F, P	M	Sh, G	E		http://plantlust.com/search/#/raw=Trachelospermum%20jasminoides http://www.monrovia.com/plant-catalog/plants/2061/star-jasmine.php
Tulbaghia violacea	Society garlic	F, P	M	Ps, G	E		http://plantlust.com/search/#/raw=Tulbaghia%20violacea http://www.monrovia.com/plant-catalog/plants/2174/tri-color-society-garlic.php
Verbena lilacina	Lilac Verbena	F	L	Ps, G	E	Yes	http://plantlust.com/search/#/raw=Verbena%20lilacina http://plantlust.com/plants/verbena-peruviana/
Verbena peruviana	Peruvian verbena	F	L	Ps, G	D		http://plantlust.com/search/#/raw=Verbena%20peruviana
Vitis spp.	Grape vine	F	M	V	D	Some	http://plantlust.com/search/#/raw=vitis
Westringia fruticosa	Westringia	F	L	Ps, Sh	E		http://www.smgrowers.com/products/plants/plantdisplay.asp?plant_id=2116
Wisteria sinensis	Chinese Wisteria	P, F	M	V	D		http://plantlust.com/search/#/raw=Wisteria%20sinensis http://www.monrovia.com/search.php?query=Wisteria+sinensis&x=7&y=11
Wisteria frutescens	American Wisteria	P, F	M	V	D		http://plantlust.com/search/#/raw=Wisteria%20frutescens http://www.monrovia.com/plant-catalog/plants/2239/amethyst-falls-american-wisteria.php
Zauschneria spp.	California Fuchsia	F	M	Ps, G	E	Some	http://www.monrovia.com/search.php?query=Zauschneria+spp.&x=4&y=12

P = Part Sun	L = Low water use	Sh = Shrub	E = Evergreen
F = Full Sun	M = Moderate water use	G = Groundcover	D = Deciduous
	VL= Very low water use	T = Tree	
		Ps = Perennial	

Appendix B – Tracking Your Water Use

Designing a water efficient landscape is only part of the water management task. After the landscape is designed and installed, using the water conserving landscape principals, it is essential to track its water use over the year in order to make certain that the irrigation system is applying the correct amount of water. Any landscape, even one based on low water use plants, can and will use more water if that water is applied by an improperly programmed controller. The easiest way to avoid this is to track your water use by reading your water meter at the end of every month and recording the meter reading on the water tracking worksheet in the ELBW, or on a table of your own devising.

Reading Your Water Meter

Reading a water meter is simple. We have included instructions here for reading your meter to the nearest cubic foot of water, which is what we need to do in order to track monthly irrigation water use. Figure 4 shows a typical water meter that reads in cubic feet of water. Notice that the meter has three elements on its face: a small triangular leak indicator, a sweep hand and a register containing 6 rotating dials.

Figure 4: A typical older water meter reading in cubic feet (CF) reading = 54,437 CF or 574 BU

Figure 5: Typical newer type meter reading 7087.5 cf, or 71 BU

The leak indicator will rotate with even a very small flow of water, so it you see it turning slowly that means there is a small flow, probably a leak, occurring in your piping system.

The sweep hand registers flows in tenths and hundredths of cubic feet. Notice that one revolution of the sweep hand equals 1.0 CF, which will advance the 1st dial of the register by 1 unit. Unless you are measuring a small volume of water there is no reason to read any further than to the nearest whole unit, and you should ignore the sweep hand. The left four dials are black letters on a white background, which show the reading in hundreds of cubic feet (billing units), and the first two dials are white on black, which show the reading to the nearest cubic foot. This meter is reading 574 BU, which is the number that will appear on the water bill. In order to track your water use for monitoring your irrigation use you should read all of the numbers on the dial, and read to the nearest CF, which in this case is 57,437 CF. This is the number you should enter onto the tracking worksheet.

Recording your monthly use

Table 13 shows a form that is part of the ELBW that you can use to track your monthly water use during the year. This can be printed out and posted in a convenient place. The monthly water meter readings in this table have been entered through the end of April in column 5 of the table. Note that this table assumes that you have followed the CALGreen recommendation of installing a separate irrigation meter, and that no adjustment is needed to eliminate indoor use from the readings. Column 6 shows the monthly water use and column 7 shows the percent of the monthly budget used during the month. Totals are shown at the bottom of the table.

Table 13 : Monthly tracking table at the start of the year

Monthly Water Budget Tracking Sheet (for dedicated irrigation meter)						
Month	ETo	Percent of Annual Total	Monthly Irrigation Budget	End Of Month Water Meter Reading	Actual Amount Used (CF)	Percent of Budget
	(FT)	%	(CF)	(CF)	(CF)	%
December				1000.00		
January	0.21	4.3%	85	1085.00	85.00	100%
February	0.26	5.4%	106	1185.00	100.00	94%
March	0.34	7.2%	141	1328.00	143.00	102%
April	0.46	9.6%	189	1517.00	189.00	100%
May	0.54	11.4%	223		0.00	0%
June	0.59	12.3%	241		0.00	0%
July	0.61	12.8%	252		0.00	0%
August	0.60	12.6%	248		0.00	0%
September	0.50	10.4%	204		0.00	0%
October	0.33	7.0%	136		0.00	0%
November	0.21	4.3%	85		0.00	0%
December	0.13	2.7%	53		0.00	0%
Total	4.78	100.0%	1,963	5115.00	517.00	26%
Total BU			19.63	51.15	24.50	

Annual and cumulative tracking of the actual use versus the budget is provided in Figure 6 and Figure 7. The former compares the monthly use versus the monthly budgets and the later shows the cumulative use versus the cumulative budget all in cubic feet.

Filling in this table takes only a few moments each month, and will assure you that your irrigation system is performing as intended. If you notice that the applications are starting to vary, either upwards or downwards from the budgets, you will need to check your controller to make sure all of the zones have the proper times programed in, and to make adjustments as necessary to bring it back into line.

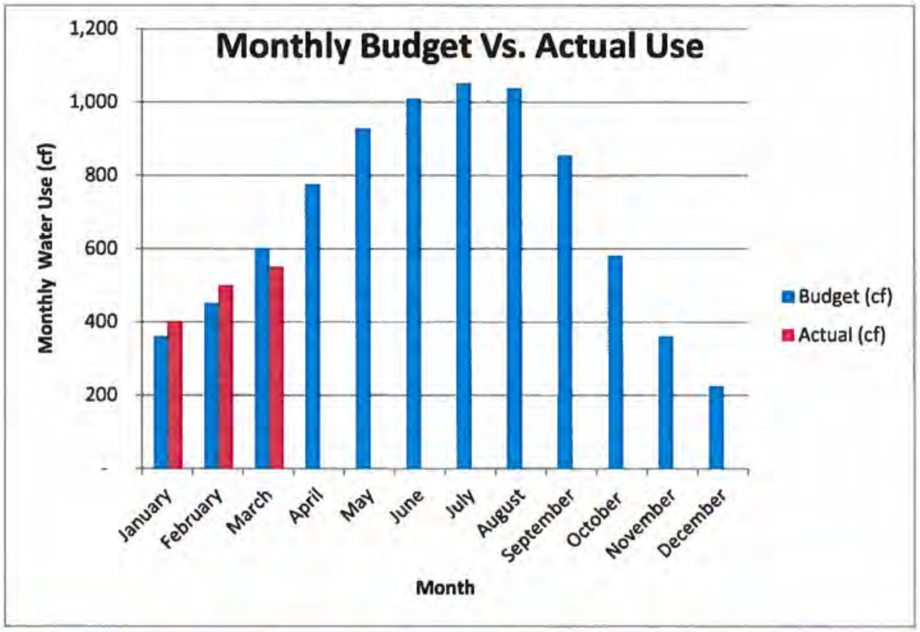


Figure 6: Figure showing Jan-Mar monthly irrigation use vs. monthly budget

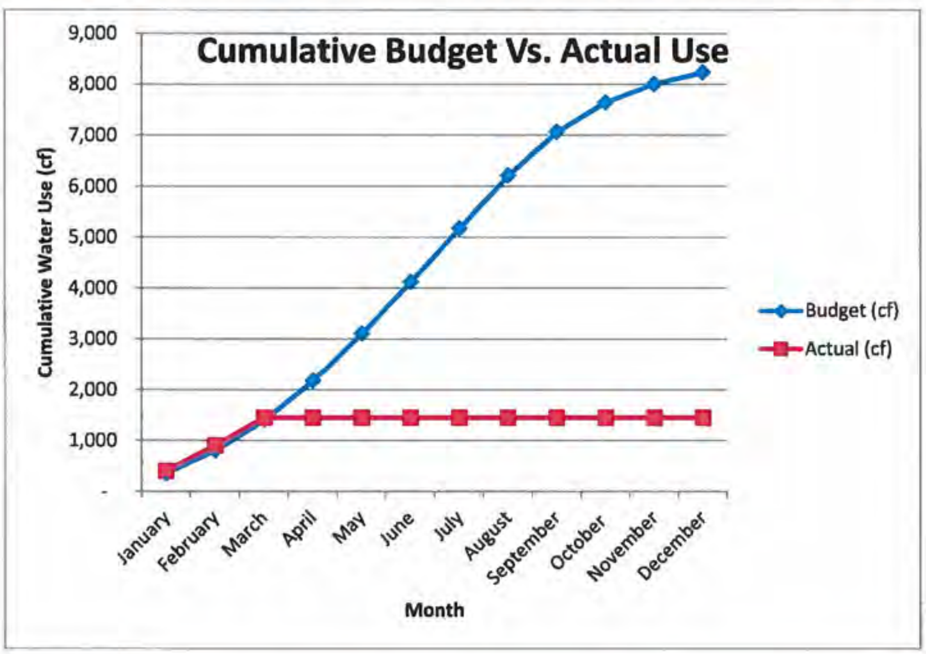


Figure 7: Figure showing cumulative irrigation use vs. cumulative water budget Jan-Mar

Appendix C – EMWD Water Efficient Guidelines Conservation Checklist

Use this checklist to ensure that water efficiency has been maximized based on the guidelines recommendations in this document.

Bathrooms

- ☐ 1.0 GPF toilets (or lower flush volume fixtures)
- ☐ 1.5 – 1.75 GPM shower heads
- ☐ 0.5 GPM lavatory faucet aerators (or lower flow fixtures)

Laundry

- ☐ ENERGY STAR rated clothes washer with an average volume allowance of 15 gallons per load or less. Clothes washers must have a maximum water factor (WF) of 4.0 to qualify for a rebate.

Landscape

- ☐ Design landscape to meet EMWD water budget requirements using a conservation factor (CF) of 0.6 (60% of ET) to ensure water efficiency.
- ☐ Employ the Seven Principles of Water Conserving Landscapes
    - Create a landscape plan
    - Prepare the soil
    - Create practical turf areas
    - Group plants into appropriate hydrozones
    - Irrigate efficiently
    - Mulch
    - Proper maintenance

Appendix D – Importance of Water Conservation in the Inland Empire

Water conservation is essential in the Inland Empire because we live in a rapidly growing region with a hot, dry climate and it is becoming increasingly difficult and expensive to secure additional water supply. Conserving the water we already have is the easiest, quickest, and least expensive source of new supply.

Conserving the water we already have is the easiest, quickest, and least expensive source of new supply.

Climate

EMWD has a semi-arid climate characterized by hot, dry summers and cooler winters. The average total rainfall is between 10 and 11 inches, occurring mostly in December through March. The region experiences a wide variation in rainfall and periodic local drought. The average annual evapotranspiration rate, ET_o, which is the quantity of water evaporated from soil surfaces and transpired by plants during a specific time, is 57.33 inches.

Population Growth

The Inland Empire region is expected to experience substantial growth over the next 20 years from a forecast population of 779,857 people in 2015 to 1,111,729 in 2035. This represents a 43% increase in population over the next 20 years.

Cost of New Supply

In 2013, EMWD can purchase water from the Metropolitan Water District of Southern California (MWD) at an annual cost of $997 per acre-foot (at the Tier 2 rate). If recent MWD rate increases are repeated, over the next 20 years this rate is expected to increase to nearly $1,800 per AF in 2030. If customers in EMWD can conserve water in 2013 for less than $997 per AF and in 2030 for less than $1,800 per AF, these savings should be cost effective and in the benefit of both EMWD and the customer.

Water Conservation

If conservation and efficiency can be "built in" to all new buildings, then water savings will accrue for years to come and additional interventions to modify demands in these buildings will not be necessary.

The Eastern Municipal Water District seeks to reliably provide high quality drinking water at a reasonable price to our customers. Conserving water is critical to helping EMWD achieve this goal. EMWD has planned, developed, and implemented a comprehensive water conservation program that addresses all customers in the service area through our water budget-based rate structure and through a wide variety of utility sponsored water efficiency programs.

This guidebook for new development was created in the hopes of improving the water efficiency of new residential construction, and in assisting our customers in managing their water use. If conservation and efficiency can be "built in" to all new buildings, then water savings will accrue for years to come and

additional interventions to modify demands in these buildings will not be necessary. Getting it right the first time makes good sense.

Appendix E – Glossary

Acre-foot	Enough water to cover an acre of land one-foot deep (i.e., 325,851 gallons, or 43,560 cubic feet).
Adjustment factor	A decimal fraction used to modify reference evapotranspiration to reflect an efficiency standard.
Aerate, aeration	Also called coring. Mechanical cultivation of turf grass using hollow tines to remove cores of turf, thatch and soil; improves soil texture and increases air and water movement in root zone.
Aerator	A screen-like component of a faucet or showerhead that reduces volumetric flow by introducing air into the stream of water.
Application rate	The depth of water applied to a given area over time, usually measured in inches per hour.
Applied water	The portion of water supplied by the irrigation system that reaches the soil surface.
Area	Square footage or acreage measured or estimated from scale plans, photographs, or from on-site measurements.
Arid climate	A climate characterized by less than 10 inches of annual precipitation.
Audit (irrigation)	An evaluation of an irrigation system to determine the proper scheduling for the distribution characteristics of the system. The Irrigation Association has a set standard of irrigation auditing procedures.
Audit (site)	A census of water uses at a site. Performed to identify areas of potential water conservation.
BU or billing unit	One CCF or one hundred cubic feet. Each billing unit is equal to 748 gallons of water.
CALGreen	California Green Building Standards Code. Requirements meant to encourage green building design and green construction practices.
CCF or HCF	One hundred cubic feet equal to 748 gallons of water. Also known as a billing unit or "BU".
CF or Cubic Foot	One cubic foot equals 7.48 gallons of water.
CIMIS	California Irrigation Management Information System: A network of 120 weather stations found throughout California. Managed by the Department of Water Resources. Provides irrigation demand information including inches of evapotranspiration (ET) and other weather parameters.

Conservation	The US Water Resources Council defines water conservation as activities designed to (1) reduce the demand for water, (2) improve efficiency in use and reduce losses and waste of water, and (3) improve land management practices to conserve water.
Conservation Factor or CF	A percentage of ET_o used to calculate the water budget for a landscape. A CF of 50% reduces the water budget by 50% of ET_o.
Conservation pricing	Billing rates that encourage water conservation. See Inclining block rate.
Conservation rate structure	A pricing structure billed by the quantity of commodity delivered and tied to the costs associated with that delivery, designed to provide an accurate price signal to the consumer. An increasing block rate structure, if the top tier equals the utility's marginal cost of new water, is one example of a conservation rate structure.
Cost-effective	When the present value exceeds the present costs.
Cost-effectiveness	An analysis that compares the financial benefits of water savings to the costs needed to achieve those savings.
Costs	The resources needed for a course of action.
Crop coefficient (Kc)	A factor used to adjust reference evapotranspiration and calculate water requirements for a given plant species. (Also called plant factor or landscape coefficient)
Drip irrigation	The slow, accurate application of water directly to plant root zones with a system of tubes and emitters usually operated under reduced pressure.
Drought	An extended period of below-average precipitation resulting in a reduction of water in available storage that can result in a cutback in water service to customers.
Effective precipitation (EP)	The portion of total rainfall that is available for use by the plant.
Efficiency	A measure of the amount of water used versus the minimum amount required to perform a specific task. In irrigation, the amount of water beneficially applied divided by the total water applied.
Efficiency standard	A value or criteria that establishes target levels of water use for a particular activity.
ELBW	Eastern Municipal Water District Landscape Budget Worksheet
EMWD	Eastern Municipal Water District
End use	A fixture, appliance, or other specific object or activity that uses water.
Energy Policy Act of 1992 (EPAct)	This Act established water use standards for toilets, urinals, showerheads, and faucets installed in the United States.

ET factor	A factor used to set a landscape water efficiency goal. Also known as a "conservation factor".
Evapotranspiration (ET)	The quantity of water evaporated from soil surfaces and transpired by plants during a specific time. According to CIMIS, evapotranspiration (ET) is the loss of water to the atmosphere by the combined processes of evaporation (from soil and plant surfaces) and transpiration (from plant tissues).
ET_o	Reference Evapotranspiration (ET_o) is a measurement of the water requirement of a reference crop, normally cool season turf. ET_o is measured in inches or gallons per square foot (= inches x 0.623). It is an indicator of how much water crops, lawns, gardens, and trees need for healthy growth and productivity.
Flow rate	The rate at which a volume of water flows through pipes, valves, etc. in a given period of time. Often reported as cubic feet per second (CFS) or gallons-per-minute (GPM).
Hardscape	Landscaping that does not permit water to seep into the ground, such as concrete, brick and lumber.
H-axis clothes washer	Horizontal-axis clothes washer.
High efficiency clothes washer (HECW)	A type of clothes washer meeting certain water and energy standards. They often involve a design where the tub axis is more nearly horizontal than vertical. Clothes are tumbled through water that only fills a fraction of the tub. Also known as a horizontal axis, tumble action or front-loading clothes washer.
Hot water on demand system	A system of pumping hot water more quickly from the water heater to the fixture calling for water for the purpose of reducing the wait time (and associated waste) for hot water.
Hydrozone	An area of landscape with plants having a similar water requirement. This can be in one or more irrigation zones, but no irrigation zone should contain plants with different water requirements.
Irrigated area	The portion of a landscape that requires supplemental irrigation, usually expressed in square feet or acres.
Irrigation audit	An evaluation of an irrigation system to determine the proper scheduling for the distribution characteristics of the system. The Irrigation Association has a set standard of irrigation auditing procedures.
Irrigation controller	A mechanical or electronic clock that can be programmed to operate remote-control valves to control watering times.
Irrigation cycle	A scheduled application of water by an irrigation station defined by a start

	time and its duration. Multiple cycles can be scheduled, separated by time intervals, to allow infiltration of applied water.
Irrigation efficiency (IE)	A value representing the amount of water beneficially applied, divided by the total water applied. Also, the product of decimal equivalents representing hardware efficiency and management efficiency.
Irrigation plan	A two-dimensional plan drawn to scale expressing the layout of irrigation components and component specifications. Layout of pipes may be depicted diagrammatically, but location of irrigation heads and irrigation schedules should be specified.
Irrigation scheduling	The process of developing a schedule for an automatic irrigation system that applies the right amount of water, matched to the plant needs, which varies daily, weekly, or seasonally.
Irrigation station	A group of irrigation components, including heads or emitters and pipes, controlled / operated by a remote control valve.
KGAL or kgal	Kilo-gallon or one thousand gallons.
K_C - species coefficient	The fraction of the amount of water a specific plant needs in relation to the reference crop.
K_d - density coefficient	The percent of the landscape zone area that is covered by plants.
K_m - microclimate coefficient	A factor that accounts for the environmental factors (such as sun, wind, soil moisture) in the irrigated zone.
K_L - landscape coefficient	The product of the species factor (K_C) x density factor (K_D) x micro climate factor (K_{MC}) determined for each irrigated zone in the system.
Landscape coefficient	A factor used to determine evapotranspiration for a specific site and set of plants. The landscape coefficient is a function of plant type, plant density and microclimate.
Landscape ratio (R_L)	This is the ratio of the theoretical irrigation requirement to the reference requirement. The landscape ratio is equivalent to the conservation factor used in the EMWD water budget formula.
Landscape water budget (LWB)	A volume of applied irrigation water expressed as a monthly or yearly amount, based on ET_o and the plant material being watered.
Meter (water)	An instrument for measuring and recording water volume.
MAWA	The maximum applied potable water allowance. As defined in the California Model Efficient Landscape Ordinance (MELO). It is based on a percent of ET_o times the landscape area. As used in MELO it is 70% of ET_o for new landscapes. In the California Green Building Code it is either 65% for tier 1 status or 60% for tier 2 status (both of these are voluntary measures).

MELO	California Model Efficient Landscape Ordinance
Meter register	Mechanical device (sometimes used synonymously with the term "Face") that uses a system of gear reductions to integrate the rotation of the moving element of a meter's measuring chamber into numerical units.
Mulch	A protective covering of various substances, usually organic, such as wood chips, placed on the soil surface around plants to reduce weed growth and evaporation and to maintain even temperatures around plant roots.
Native and adopted plants	Plants indigenous to an area or from a similar climate that require little or no supplemental irrigation once established.
Per capita residential use	Average daily water use (sales) to residential customers divided by population served.
Potable water	Water that meets federal and state water quality standards for water delivered to utility customers.
Rain shutoff device	A device connected to an irrigation controller that overrides scheduled irrigation when significant precipitation is detected.
Reference evapotranspiration (ET_o)	The water requirements of a standardized landscape plot, specifically, the estimate of the evapotranspiration of a broad expanse of well-watered, 4-to-7 inch-tall cool-season grass.
Reference Requirement	The volume of water required by a landscape composed of the reference crop, based on ET_o. Determined by multiplying the irrigated area (SF) * the ET_o (In) * 0.623 (GPSF/in)= Reference Requirement (GAL)
Service area (territory)	The geographic area(s) served by a utility.
Soil amendment	Organic and inorganic materials added to soils to improve their texture, nutrients, moisture holding capacity, and infiltration rates.
Soil improvement	The addition of soil amendments.
Solar radiation	Energy from the sun. The single most dominant factor in determining ET values, measured by a lysimeter.
Spray head	A sprinkler irrigation nozzle installed on a riser that delivers water in a fixed pattern. Flow rates of spray heads are high relative to the area covered by the spray pattern.
Spray irrigation	Sprinkler irrigation using spray heads on fixed or pop-up risers and having relatively high precipitation rates.
Sprinkler irrigation	Overhead delivery of water spray heads, stream rotors, or impact heads. Precipitation rates will vary depending on system layout and type of head used.

Sprinkler run time	The minutes of irrigation per day, based on the weekly irrigation requirement and irrigation days per week.
Sprinkler station	A group of sprinklers controlled by the same valve.
Sprinkler valve	The on-off valve, usually electric, that controls an irrigation or sprinkler station.
Stream rotors	Sprinkler irrigation heads that deliver rotating streams of water in full or partial circles. Some types use a gear mechanism and water pressure to generate a single stream or multiple streams. Stream rotors have relatively low precipitation rates, and multiple stream rotors can provide matched precipitation for varying arc patterns.
Structured plumbing system	Properly sized and well insulated hot water main and hot water risers, including a dedicated hot water main segment connecting the farthest hot water point of use to the water heater.
Subsurface drip irrigation	The application of water via buried pipe and emitters, with flow rates measured in gallons-per-hour.
Thatch	The buildup of organic material at the base of turf grass leaf blades. Thatch repels water and reduces infiltration capacity.
Theoretical Irrigation Requirement (TIR)	The actual amount of water required by a landscape, based on the irrigated areas, plant types, irrigation efficiencies and ET_o.
Toilet flapper	A pliable valve in the opening at the bottom of a toilet tank that regulates water flow into the toilet bowl.
Ultra Low Flush Toilet (ULFT)	A toilet that flushes with 1.6 gallons or less.
Utility	Used alternately to describe a provided resource, such as water, gas, electric as well as for the provider of the resource
Water audit	1) An on-site survey of an irrigation system or other water use setting to measure hardware and management efficiency and generate recommendations to improve its efficiency. 2) For water distribution systems, a thorough examination of the accuracy of water agency records and system control equipment to identify, quantify, and verify water and revenue losses. See also Audit (site), Audit (system), Audit (irrigation).
Water budget	The calculated water allocation for a landscape based on a percentage of ET_o and the landscape area.
Water conservation	The US Water Resources Council defines water conservation as activities designed to (1) reduce the demand for water, (2) improve efficiency in use and reduce losses and waste of water, and (3) improve land management practices to conserve water.

Water use efficiency	A measure of the amount of water used versus the minimum amount required to perform a specific task. In irrigation, the amount of water beneficially applied divided by the total water applied.
Water-efficient landscape	A landscape that minimizes water requirements and consumption through proper design, installation, and management.
Xeriscape	Landscaping practice based on seven principles: proper planning and design; soil analysis and improvement; practical turf areas; appropriate plant selection; efficient irrigation; mulching; and appropriate maintenance.

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