

## Revised WaterSense® Water Budget Approach

### I. Introduction

On May 8, 2009, EPA released a revised draft of the [specification for water-efficient single-family new homes](#) (specification). To meet the Landscape Design Criteria (Section 4.1.1), the builder may choose to comply with one of the following options:

Option 1 – Turfgrass shall not exceed 40 percent of the landscapable area.

Option 2 – Landscape design shall be developed using the water budget approach and tool based on a 70 percent evapotranspiration adjustment factor.

EPA has developed a tool to guide the builder, landscape professional, or WaterSense irrigation partner through the water budget calculations. The first version of this tool, released on November 20, 2008, was based on methodology developed by the irrigation industry as described in the Irrigation Association (IA)'s *Landscape Irrigation Scheduling and Water Management*, published in March 2005. This second version incorporates recommendations suggested by stakeholders as part of the public comment process.

This document provides an overview of the tool as well as detailed instructions for using the tool. Definitions of technical terms are provided at the end of the document.

The water budget approach serves as a design tool, allowing the professional to design a sustainable landscape based on a regionally appropriate amount of water. A water budget is a site-specific method of calculating an allowable amount of water to be used by the landscape and then designing the landscape to meet this budget. The budget takes into account plant type, plant water needs, irrigation system design, and applied water that the landscape receives either by irrigation or by precipitation, as described in detail below. Water budgets must be associated with a specified amount of time, such as a week, month, or year. This tool is based on the site's peak watering month. For most of the United States, the peak watering month is July.

WaterSense designated a 70 percent evapotranspiration adjustment factor in Option 2 of the specification's Landscape Design Criteria (Section 4.1.1). This means that the designed landscape is allowed to use 70 percent of the amount of water required by a similar-sized landscape composed entirely of turfgrass. It does not mean that each hydrozone of the designed landscape can receive only 70 percent of the water that the plants need. The water budget approach will allow users to plant a mixture of high-, medium-, and low-water-using plants, lending flexibility in the design of the water-efficient landscape.

### II. Who Should Use the Tool?

If the builder chooses Option 2 of the Landscape Design Criteria (4.1.1), the WaterSense Water Budget Tool shall be used and documentation shall be submitted as part of the inspection package. Although the tool is based on the assumption that the designed landscape has an in-

ground irrigation system, designers that choose not to install an irrigation system shall still use the tool if they choose Option 2. Details on completing the tool for a landscape without an irrigation system are discussed in [Section B.3.c](#). However, if a landscape is more than 50 percent non-vegetated area (e.g., mulch or hardscape), then the tool is not appropriate for use and Option 1 is more suitable.

### III. The Water Budget Tool

The tool (file name: WaterSense Water Budget Tool\_050809.xls) is provided in a Microsoft Excel spreadsheet format that guides the user through the water budget calculation in three parts. First, the tool calculates the amount of water the designed landscape is allowed based on EPA criteria (Part 1 – Landscape Water Allowance). Next, the tool calculates how much water the designed landscape requires based on climate, plant type, and irrigation system design (Part 2 – Landscape Water Requirement). Last, the tool compares the allowable amount of water from Part 1 to the required amount of water from Part 2 and determines whether the designed landscape meets EPA’s criteria (Part 3 – Results).

#### A. Background on the Calculations

The following sections describe the equations and calculations used by the tool to calculate the water budget and determine if the designed landscape meets EPA criteria.

##### Part 1: Determining the Landscape Water Allowance

The landscape water allowance (LWA) is the amount of irrigation water allotted for the designed landscape. The LWA is based on the local reference evapotranspiration ( $ET_o$ ), an evapotranspiration adjustment factor (ETAF), and the area (A) of the designed landscape:

Equation A-1: Landscape Water Allowance

$$LWA = ET_o \times ETAF \times A \times C_u$$

Where:

LWA = Landscape water allowance (gallons/month)

$ET_o$  = Local reference evapotranspiration (inches/month)

ETAF = Evapotranspiration adjustment factor (dimensionless), designated by WaterSense as 0.70 (70%)

A = Area of the landscape (square feet)

$C_u$  = Conversion factor (0.6233 for results in gallons/month)

##### Part 2: Determining the Landscape Water Requirement

The landscape water requirement (LWR) is the amount of irrigation water required by the designed landscape. The LWR is calculated for each hydrozone and the sum of these values is the LWR for the site. The LWR is based on  $ET_o$ , the landscape coefficient ( $K_L$ ), the

area of the hydrozone, the lower quarter distribution uniformity ( $DU_{LQ}$ ) of the associated system, and a portion of local rainfall designated as allowable rainfall ( $R_a$ ):

Equation B-1: Landscape Water Requirement

$$LWR_H = RTM \times [(ET_o \times K_L) - R_a] \times A \times C_u$$

Where:

$LWR_H$  = Landscape water requirement for the hydrozone (gallons/month)

$RTM$  = Run time multiplier, equal to 1/lower quarter distribution uniformity (dimensionless)

$ET_o$  = Local reference evapotranspiration (inches/month)

$K_L$  = Landscape coefficient for the highest water-using plant in that hydrozone (dimensionless)

$R_a$  = Allowable rainfall, designated by WaterSense as 25% of the site's peak monthly rainfall

$A$  = Area of the hydrozone (square feet)

$C_u$  = Conversion factor (0.6233 for results in gallons/month)

Further explanation of  $R_a$ : For the purposes of this tool, WaterSense is limiting the landscape designer to 25 percent of the peak watering month's average rainfall at the site. This is a conservative estimate to allow for a landscape to survive on less rainfall than expected and still meet the water budget.

**Part 3: Results**

This worksheet is used to compare the LWA to the LWR to determine if the water budget is met. If the LWR is **LESS** than the LWA, then the water budget criterion is met. If the LWR is **GREATER** than the LWA, then the water budget criterion is not met and the landscape design and/or irrigation system needs to be redesigned to use less water.

Additionally, this worksheet will calculate and display the total amount of turfgrass used in the landscape. This information is necessary for the inspector to verify the builder actually installed the designated amount of turfgrass at the home site.

**B. Detailed Instructions**

Each worksheet is formatted in an identical fashion:

- The blue section at the top displays the user, builder, and site information. Once the information is entered for Part 1, it is automatically populated into Parts 2 and 3 of the tool.
- The yellow section displays the equation that is used in each worksheet.
- The gray section is the area of the worksheet where the user enters the required data.
- The green section displays the result.

Please note, the tool only allows information to be entered into the white cells.

## Part 1: Determining the Landscape Water Allowance

1. Complete the site information in the blue section at the top of the worksheet. Enter the peak watering month for the site. The peak watering month is the month when the plants in the site's region require the most water. For most regions of the United States, the peak watering month is July. If you are unsure of the peak watering month for your area, contact your local water utility. Site information entered on this tab will be populated automatically in the next two worksheets.
2. In the gray section, complete Step 1A by entering the area of the landscape in square feet. Note: For purposes of this tool, the landscapable area is defined as "Buildable lot area excluding area under roof. Buildable lot area is the portion of a site where construction can occur. Buildable land excludes public streets and other public rights-of-way, land occupied by nonresidential structures, public parks, and land excluded from residential development by law. Septic field drainage areas are excluded from the definition of landscapable area."
3. In the gray section, complete Step 1B by entering the monthly  $ET_o$  for the site's peak month. For this version of the tool, please use the additional resources provided in Section E to determine your local peak month  $ET_o$ . EPA is developing a Web page that will provide average monthly  $ET_o$  by zip code for users in the United States. A beta version of this tool will be available soon. The data are based on information obtained from the International Water Management Institute's (IWMI) World Water and Climate Atlas ([www.iwmi.cgiar.org/WAtlas/Default.aspx](http://www.iwmi.cgiar.org/WAtlas/Default.aspx)), which calculates Penman-Monteith reference evapotranspiration rates from 1961-1990 historical data. While local, real-time evapotranspiration data are more suitable for scheduling an irrigation system, EPA believes that the IWMI data are suitable for use when designing the landscape.
4. The result is displayed in the green section.
5. Click on the worksheet tab labeled "Part 2 - LWR" at the bottom of the screen to calculate the landscape water requirement.

## Part 2: Determining the Landscape Water Requirement

1. In the gray section, complete Step 2A by entering the monthly rainfall (R) in inches per month for the peak watering month. Rainfall data should be taken from the National Ocean and Atmospheric Administration (NOAA) 1971–2000 dataset (located at [http://cdo.ncdc.noaa.gov/cgi-bin/climatenormals/climatenormals.pl?directive=prod\\_select2&prodtype=CLIM81&subrum](http://cdo.ncdc.noaa.gov/cgi-bin/climatenormals/climatenormals.pl?directive=prod_select2&prodtype=CLIM81&subrum)). Choose the appropriate state on the right side of the screen. Open the file format of your preference (PDF or ASCII) and locate the "precipitation normals" (total in inches) for the peak watering month for the station nearest the home. Enter the corresponding average monthly rainfall into the tool.
2. Complete Step 2B by filling Table 1 with the required information. When completed, the total area of all of the hydrozones/landscape feature areas must equal the total

landscapable area to avoid an error message in Step 3. For each hydrozone/landscape feature area, complete the following information:

- a. Hydrozone/Landscape Feature Area: Enter the area of the hydrozone or landscape feature in square feet.
- b. Plant Type or Landscape Feature: From the dropdown list, choose the plant type (e.g., trees – high water requirement, turfgrass – medium water requirement, etc.) or landscape feature (i.e., hardscape, nonvegetated softscape, or pool, spa, or water feature) for the associated hydrozone/landscape feature area. If there are multiple plant types or landscape features within one hydrozone, enter the feature with the highest water requirement. The landscape coefficient ( $K_L$ ) for the respective plant type (or landscape feature) will automatically populate in the adjacent cell. The source data for the plant type dropdown list and associated  $K_L$  values are displayed in Table 2. These plant types and associated  $K_L$  values are based on the U.S. Green Building Council's (USGBC's) Leadership in Energy and Environmental Design (LEED) for Homes Rating System 2008 table of species factors (SS 2.5 Table 6) (USGBC 2008).

The landscape coefficient is a factor used to modify reference ET, which includes species factor ( $K_s$ ), density factor ( $K_d$ ), and microclimate factor ( $K_{mc}$ ). The equation for the landscape coefficient is  $K_L = K_s \times K_d \times K_{mc}$  (Landscape 2000 in IA 2005). For the purposes of this tool, WaterSense is assuming  $K_d$  and  $K_{mc}$  are both approximately equal to one to reduce the complexity of the calculations. Therefore,  $K_L = K_s$ .

In general, a high value for  $K_s$  is used for plants that need a lot of water, and a low value is used for plants that need little water. As a general rule of thumb, species requiring the indicated amounts of water are designated as follows (WUCOLS, 2000):

- 70-90%  $ET_o$ : High  $K_s$
- 40-60%  $ET_o$ : Moderate  $K_s$
- < 30%  $ET_o$ : Low  $K_s$

If you are not familiar with the  $K_s$  values for the proposed plant types, contact your local cooperative extension for guidance.

For hardscape and nonvegetated softscape, the  $K_L$  is assumed to be zero and no water requirement will be assigned in Table 1. For a pool, spa, or water feature, the associated  $K_L$  is assumed to be that of a high-water-using plant such as turfgrass and is set at 0.80.

- c. Irrigation Type and Lower Quarter Distribution Uniformity ( $DU_{LQ}$ ): For each hydrozone, choose the type of irrigation (e.g., standard drip, rotor) that will be installed. The associated  $DU_{LQ}$  will automatically populate in the adjacent cell. The data for the irrigation type and  $DU_{LQ}$  are based on the Irrigation Association's *Landscape Irrigation Scheduling and Water Management* (IA 2005).

**Note:** If the hydrozone/landscape feature area is designated as hardscape or nonvegetated softscape then choose “no irrigation” from the dropdown list. If the hydrozone/landscape feature area is designated as “Pool, Spa, or Water Feature,” then set the irrigation type to “fixed spray.”

**If irrigation is not being installed on the site at this time:** Although not installing irrigation, an irrigation type must be chosen if the hydrozone includes a plant type.

- If the  $K_L$  for the plant type or landscape feature for the hydrozone is 0.2, then choose the irrigation type to be “standard drip” for this column.
- If the  $K_L$  for the plant type or landscape feature is greater than 0.2, then choose “fixed spray.”
- If areas of the landscape are “hardscape” or “nonvegetated softscape”, choose “no irrigation” as discussed above.

- d.  $LWR_H$ : The LWR for each hydrozone, in gallons per month, will be calculated by the tool and displayed in this column.
3. The result is displayed in the green section.
  4. Click on the worksheet tab labeled “Part 3 - Results” at the bottom of the screen to review the results of the water budget tool.

### Part 3: Results

If the total area of the hydrozone/landscape feature areas entered in Part 2 does not equal the total landscapable area entered in Part 1, then an error message in red text will appear at the top of the gray section requesting that Table 1 be completed.

1. Complete Step 3A by reviewing the LWA and LWR calculated in Part 1 and Part 2.
2. Complete Step 3B by reviewing the total area of turfgrass in the designed landscape. The percentage of designed landscape that is comprised of turfgrass, pools, spas, and/or water features is also displayed.
3. The result is displayed in the green section.
  - a. If the blue cell displays “YES” then the water budget criterion is met (i.e.,  $LWR < LWA$ ). Print an entire copy of the completed tool and submit it to the builder to be included in the inspection documentation.
  - b. If the blue cell displays “NO” then the designed landscape requires more water than the site is allotted. Adjustments should be made to the composition of the landscape and/or irrigation system in [Step 2B](#) of the water budget tool. Then return to Part 3 – Results to see if the revised design meets the water budget criterion.

When all of the information has been entered into the tool and the water budget is complete, print an entire copy of the completed tool and submit it to the builder to be included in the inspection documentation. This documentation must be provided to the builder prior to a home being inspected for compliance with EPA criteria.

### C. Definitions

Allowable rainfall –The amount of rainfall WaterSense is allowing to be incorporated into the water budget. For the purpose of this tool, 25 percent of the site’s average peak monthly rainfall was designated by WaterSense. This is a conservative estimate to allow for a landscape to survive on less rainfall than expected and still meet the water budget.

Evapotranspiration adjustment factor – An adjustment factor used in the water budget tool to limit the allotment of water a landscape can be designed to use. For the purposes of this specification, EPA has set this level at 70 percent of reference evapotranspiration ( $ET_o$ ).

Hydrozone – Grouping of plants with similar water and environmental requirements for irrigation with one of more common station/zone valves (Weinberg and Roberts 1988 and Water Management Committee 2001 in IA 2005).

Landscape coefficient ( $K_L$ ) – Coefficient used to modify reference ET, which includes species factor ( $K_s$ ), density factor ( $K_d$ ), and microclimate factor ( $K_{mc}$ ). ( $K_L = K_s \times K_d \times K_{mc}$ ) (Landscape 2000 in IA 2005). Note: For the purposes of this tool, WaterSense is assuming  $K_d$  and  $K_{mc}$  are both approximately equal to one to reduce the complexity of the calculations.

Landscape water allowance (LWA) – A volume of water allocated to the entire landscape area over a specified period of time. For the purpose of this tool, the LWA is based on the local reference evapotranspiration ( $ET_o$ ), an evapotranspiration adjustment factor (ETAF), and the area (A) of the designed landscape.

Landscape water requirement (LWR) – The amount of water required by the landscape over a specified period of time.

Landscapable area – Buildable lot area excluding area under roof. Buildable lot area is the portion of a site where construction can occur. Buildable land excludes public streets and other public rights-of-way, land occupied by nonresidential structures, public parks, and land excluded from residential development by law. Septic field drainage areas are excluded from the definition of landscapable area (WaterSense 2009).

Reference evapotranspiration (grass reference evapotranspiration) ( $ET_o$ ) – Rate of evapotranspiration from an extensive surface of cool-season grass cover of uniform height of 12 centimeters, actively growing, completely shading the ground, and not short of water (FAO 1998 and ASCE 1990 in IA 2005).

Run time multiplier (RTM) – Factor used to increase zone run time to account for lack of distribution uniformity within the root zone (Water Management Committee 2001 in IA 2005).

**Softscape** – The natural elements of a landscape, such as plant materials and soil. Softscapes can include hard elements such as rocks (U.S. Green Building Council. LEED for Homes Reference Guide, First Edition, Washington, D.C, 2008).

**Water budget** – A water budget is used to calculate the amount of water a landscape needs taking into account the inputs and outputs of water to and from the root zone. Inputs, such as precipitation, are subtracted from outputs, such as evapotranspiration, to calculate the water needs of the landscape. Many factors are taken into consideration when calculating a water budget, such as plant type and irrigation system efficiencies (WaterSense 2008).

#### **D. References**

California Department of Water Resources. 2009. Model Water-Efficient Landscape Ordinance.

Irrigation Association (IA). 2005. Landscape Irrigation Scheduling and Water Management. [*Currently out for review*]

United States Green Building Council (USGBC). LEED for Homes Rating System 2008.

University of California Cooperative Extension and California Department of Water Resources. 2000. A Guide to Estimating Irrigation Water Needs of Landscape Plantings in California. The Landscape Coefficient Method and Water Use Classifications of Landscape Species (WUCOLS) III.

WaterSense. 2009. Revised Draft Water-Efficient Single-Family New Home Specification.

#### **E. Additional Resources**

The Irrigation Association's ET Connection page lists known ET sources by state and is available at: [www.irrigation.org/gov/pdf/ET\\_Conn\\_Info.pdf](http://www.irrigation.org/gov/pdf/ET_Conn_Info.pdf)

Irrisoft's InSite Irrigation Scheduling program, available for free download at: [www.irrisoft.net/wr/inSite.cfm](http://www.irrisoft.net/wr/inSite.cfm) contains historical ET data for several cities in each US state.

Rain Bird's ET Manager Scheduler program, available for free download at: [www.rainbird.com/landscape/products/controllers/etmanager.htm](http://www.rainbird.com/landscape/products/controllers/etmanager.htm) contains historical ET data for several cities in each US state.